**Select Board**
**Regular Meeting Minutes**
**March 9, 2022, 8:20am**

Present: Chair Keyes, Selectman Arcudi, Selectwoman Hazard, Town Administrator Schindler, Attorney Vetere, Attorney Durning will join in executive session.

Chair Keyes called the meeting to order 8:21AM.

Chair Keyes read the executive session paragraph and purpose below.

Selectwoman Hazard moved to enter executive session per the purpose Chair Keyes read, not to return to open session. Selectman Arcudi seconded the motion.
Arcudi – Aye, Hazard – Aye, Keyes – Aye

The Board entered executive session at 8:29AM

This meeting is exclusively for the purpose of mediation and will be held virtually through REBA Dispute Resolution, Inc.

Executive Session:
Motion: To move into Executive Session pursuant to M.G.L. c. 30A, § 21(a): paragraph 9, with respect to participation in mediations. To meet or confer with a mediator, as defined in section 23C of chapter 233, with respect to any litigation or decision on any public business within its jurisdiction involving another party, group or entity, provided that: (i) any decision to participate in mediation shall be made in an open session and the parties, issues involved and purpose of the mediation shall be disclosed; and (ii) no action shall be taken by any public body with respect to those issues which are the subject of the mediation without deliberation and approval for such action at an open session.

**REBA Dispute Resolution Mediation:** Town of Hopedale v. Jon Delli Priscoli, Trustee of the One Hundred Forty Realty Trust, Land Court Civ. Case No. 20 MISC 000467 [DRR].

**The Board returned to open session at 6:00PM**

Old Business
Update regarding Town v. Jon Delli Priscoli, Trustee of the One Hundred Forty Realty Trust, et als.
Attorney Durning stated that there was not change from the mediation proceedings. Meaning, the Town is in the same position as it was before Judge Rubin issued her mediation screening order on February 233, 2022. The Town has established a date for Town Meeting, on March 26, 2022. The articles that KP Law have prepared which address the acquisition of Parcel A settlement agreement and the GU RR's gift of Parcel D will be on the warrant. Durning stated the appropriate focus should be on the residents having the ability to assess and vote on those articles. This will be a 2/3rds vote for parcel A and a simple majority for the gift from GU RR.

Selectwoman Hazard stated that she was surprised that the Town and other parties ended up in mediation again. She feels that going forward, the Town will need to include the residents and give out as much information as possible. Selectman Arcudi stated that he feels the Board did their due diligence and he stands by his vote and the settlement agreement. He stated that he was not provided any information that proved otherwise. Chair Keyes stated he echoed Selectman Arcudi's sentiments.

Durning reiterated that there is no change to the settlement agreement. He believed there was a possibility of modifying the settlement agreement during the mediation session but that did not happen. The land acquisition portions of the settlement agreement will need to go to Town Meeting per Judge Goodwin's order.

Attorney Durning stated that the Town has made direct requests to the Railroad to refrain from development on the land prior to the Town Meeting decisions. This request is not backed by an order of the Court. Rob Fahey asked Attorney Durning to explain this point again. Durning reiterated that there is no Court imposed injunction controlling the GURR activities on the property at this time. Durning reiterated that requests were made by the Town and the 10 Taxpayers to refrain from work prior to Town Meeting. The GURR has not directly responded that they are agreeing to this. Rob Fahey asked Michael Milanowski with the GURR to comment on this. Milanowski did not make a comment.

Attorney Durning stated that pursuant to Judge Goodwin's decision, the portion of the settlement agreement that the Board lacked authority to structure the acquisitions without further authorization from Town Meeting. Durning stated that Judge Goodwin's decision also explores that in the event that Town Meeting is not held, or a Town meeting vote is against the acquisition, then the transfer of title that's contemplated in the settlement agreement would not occur. The 140 Realty Trust would own the property outright. Selectman Arcudi made note of this distinction. Chair Keyes stated that he recommends the residents take a serious look at the settlement agreement and the risk assessment of what a no vote would mean to the Town. Chair Keyes stated that the Town is currently in the red regarding getting legal fees paid, this is something that the Board has had to take into consideration regarding ongoing litigation.

Review & Sign Special Town Meeting Warrant (vote)
Town Administrator Schindler shared the Special Town Meeting Warrant with the Board and public. Article 8 and 9, were discussed by the Town's Counsel. Attorney Riley stated that Article 8 is asking the Town to authorize the Select Board to acquire of Parcel A and to appropriate funds to pay for that, roughly $187,000. Riley stated that Article 9 is regarding the portion of land that the GURR has offered to donate to the Town.

Article 1-7: Schindler stated that Finance Committee has not provided their recommendations regarding the Articles. She is not aware of if they recommend this article or not. Attorney Riley stated that this is fine if the Finance Committee weighs in on the articles on, they have reviewed. Town Administrator Schindler reviewed Articles 1-7 with the Board.

Selectman Arcudi moved to close the warrant and its articles for the March 26, 2022 Special Town Meeting. Selectwoman Hazard seconded the motion.
Arcudi – Aye, Hazard – Aye, Keyes – Aye

Selectwoman Hazard moved to adjourn the regular meeting. Selectman Arcudi seconded the motion.
Arcudi – Aye, Hazard – Aye, Keyes – Aye

Chair Keyes dissolved the meeting at 7:59PM.

*Submitted by:*
*__Lindsay Peterman_________*
*Executive Assistant*
*Adopted: ________*

| | |
|---|---|
| **From:** | Derek Piatt |
| **To:** | Lindsay Peterman |
| **Subject:** | Re: Finance Committee Appointment |
| **Date:** | Wednesday, March 16, 2022 6:34:34 PM |

Lindsay,

Thank you for your patience. I am deployed and unable to participate at this time. Please consider this my letter of resignation.

Thanks again!

Derek J. Piatt

On Wed, Mar 16, 2022 at 9:39 AM Lindsay Peterman <lpeterman@hopedale-ma.gov> wrote:

> **From:** Lindsay Peterman
> **Sent:** Monday, March 7, 2022 11:18 AM
> **To:** Derek Piatt
> **Cc:** Diana Schindler <DSchindler@hopedale-ma.gov>; Hopedale Finance Committee <Finance@hopedale-ma.gov>
> **Subject:** Finance Committee Appointment
>
> Hi Derek,
>
> I hope this email finds you well. It was requested that I reach out to you regarding your Hopedale Finance Committee Appointment. I was notified that you have not been active on the Committee and I wanted to request a resignation letter/email notice from you.

**TOWN OF HOPEDALE**
**BOARD, COMMISSION OR COMMITTEE**
**TALENT BANK FORM**

Local Government needs citizens to give of their time and talents serving the Town of Hopedale. A Talent Bank has been established to compile a list of interested citizens, willing to serve on a voluntary basis on boards, commissions and committees. Some groups meet often, others require less time, and still others are busy only at specific times of the year. Occasionally, there are requirements for ad hoc committees or sub-committees appointed to work on specific projects. Experience indicates that the two most appropriate qualities for successful service are an open mind and exercise of common sense.

If you are interested in serving, please list the position(s) you wish to be considered for:

Board, Commission or Committee applying for:

Finance Committee

Please return completed forms to:

Town Administrator's Office – Hopedale Town Hall 78 Hopedale Street, Hopedale, MA 01747

The Town Hall mailing address is: P.O. Box 7, Hopedale MA, 01747

Please Note:

- The Board of Selectmen may fill vacancies until next election.
- It is recommended that you attend a few meetings of the committee or board you are contemplating joining to help determine your interest.
- The board/committee will be asked for their recommendation on each applicant appointment.

Name: Stephen Capuzziello Jr    Are you a registered voter? ☒ Yes ☐ No

Address[redacted]    How long have you lived in Hopedale? 1 yr

Home Phone: —    Cell Phon[redacted]E-Mail:[redacted]

How would you like to be contacted? Cell Phone/email

Occupation: Sales Manager, Hasbro Inc

Please list any potential conflicts of interest, e.g. membership in an organization or your

business: N/A

Education and Experience: 2014 B.A. Gordon College 3.5 GPA / 6 years in various roles at Hasbro / lead + planned Multiple service trips thru Faith Community Church

How many times during the last year have you attended a meeting of the Board/Committee to which you are requesting appointment? 0

Have you ever had business before the Board/Committee to which you are requesting an appointment?

☐ Yes ☒ No If yes what type of business? ___

Special interests and skills: Planning, Financial projections, Project Management, Forecasting, Budgeting

Activities, e.g. Government/Civic & Community/Charitable & Educational: Volunteer at Faith Community Church

Reasons for wanting to serve: Interest in helping the Town via Finance Committee

*The completion of this form in no way assures appointment. Citizens deemed most qualified to serve in a particular capacity will fill all board, commission or committee vacancies.*

Applicant's Signature [signature] Date 3/4/2022

Select Board or Hopedale,

Thank you for the consideration to be on the town Finance Committee and thank you to Chris Hodgens for the endorsement.

I am originally from Upton, where I attended Nipmuc Regional Highschool, graduating in 2010. From there I attended Gordon College, graduating in 2014, and majoring in Business Management and minoring in Non-Profit Organizations. I recently moved to Hopedale in February of 2021.

My great grandmother and many of my great aunts and uncles worked at the Draper Factory. I remember one of my aunts telling me what a wonderful place it was to work because of the way the Draper company took care of their employees. Hopedale provided my relatives a place of employment and is a town of great history and success, and I would enjoy and cherish the chance to be able to give back by serving on the Finance Committee.

I have worked for Hasbro for the past 6 years in various sales positions on the Amazon, Target, and B2B accounts at Hasbro. Over those years I have gained knowledge of how to interact with top accounts, close business deals, and financially and strategically plan. I have also served as a youth leader at Faith Community church since 2012 where I have overseen and planned various mission trips around the globe. I believe my experiences in these roles will be able to help guide Hopedale in their financial planning and decision-making processes to be a fiscally strong town.

Thank you for the consideration,

Stephen Capuzziello Jr

**From:** Keith Smith
**To:** Lindsay Peterman; Brian Keyes; Diana Schindler
**Cc:** Brett Bouvier
**Subject:** RE: [Town of Hopedale MA] HYBA Baseball Parade (Sent by Keith Smith) Wednesday, March
**Date:** 16, 2022 8:44:33 AM

---

Hi Lindsay,
Hope all is well with you today.

- The parade will start at 11 am. We would like the kids to start lining up at the community house lawn between 10 and 11.
- The parade will start in front of draper gym and end at draper field: route: Dutcher St to Freedom st.
- Participants in the parade about 100 – 130. As for people along the parade route I would be guessing but maybe 200 from start to finish. There tends to be a big group at the start of the parade and down by draper field. Sorry I can't be more specific.

I did reach out to Hopedale Police and Fire as we will certainly need their assistance and I wanted to let them know the date.

We will be running a concession stand this spring and would like to start on Parade day.

Please let me know if you have additional questions or if you need more information?

Thank you

**Keith Smith**
*Director of Sales*
617.823.3249

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**From:** Lindsay Peterman <lpeterman@hopedale-ma.gov>
[redacted] 14, 2022 11:11 AM
**Subject:** [EXTERNAL] RE: [Town of Hopedale MA] HYBA Baseball Parade (Sent by Keith Smith,
**Security notice: This e-mail was sent from outside of Creative Office Pavilion. Be cautious if you were not expecting this e-mail.**

---

Hi Keith,

I hope this email finds you well. I will add this item to the upcoming Select Board agenda on March 28, 2022. Could you please provide me some additional information regarding the parade?

1. What time does the parade start and end on April 23, 2022
2. Where does the parade start and end
3. In past years, how many people typically attend the parades

I will reach out to the Hopedale Health Agent to get COVID guidance regarding this.

Thank you!
Lindsay Peterman
Executive Assistant to the Town Adminsitrator

---

**From:** Brian Keyes <bkeyes@hopedale-ma.gov>
**Sent:** Monday, March 14, 2022 10:46 AM
**Subject:** Re: [Town of Hopedale MA] HYBA Baseball Parade (Sent by Keith Smith)

Hi Keith,

Great to hear from you and things are going pretty well on this end. This is fabulous news and excited to hear another example of us getting back to a sense of normalcy, especially in the area of our youth sports.

I am adding Diana Schindler our Town Administrator to add to our next meeting agenda for the Board to approve. Also, Diana, could you reply back if there is need for Keith to contact directly our Health Agent and/or Board of Health for the parade with us technically still being in the pandemic climate?

This is great news and look forward to attending the event.

My Best,
Brian

**From:** Contact form at Town of Hopedale MA <cmsmailer@civicplus.com>
**Sent:** Monday, March 14, 2022 9:55 AM
**To:** Brian Keyes <bkeyes@hopedale-ma.gov>
**Subject:** [Town of Hopedale MA] HYBA Baseball Parade (Sent by Keith Smith)

Hello bkeyes,

Keith Smith has sent you a message via your contact form (https://www.hopedale-ma.gov/user/216/contact) at Town of Hopedale MA.

If you don't want to receive such e-mails, you can change your settings at https://www.hopedale-ma.gov/user/216/edit.

Message:

Hi Brian,

Hope all is well on your end. Been a couple years but we are looking to hold the baseball parade on 4/23. Do we need to secure a permit and who should I get that through?
Thank you

| | |
|---|---|
| **From:** | Bill Fisher |
| **To:** | Lindsay Peterman |
| **Subject:** | RE: [Town of Hopedale MA] HYBA Baseball Parade (Sent by Keith Smith, ksmith@cop-inc.com) |
| **Date:** | Wednesday, March 16, 2022 10:31:21 AM |

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Hi Lindsay
The Covid positivity rate in Hopedale is currently 1.5% .This is a low number finally so that restrictions wont be required.Do you know if there will be any food venders for this event This is an outside gathering so the risks of transmission  would be much lower.
Both participants and spectators should be able to enjoy the parade in the open air.I would advise anyone with health issues or suppressed immunity or recent exposure to Covid  to wear a mask and encourage anyone that wants to wear a mask to do so as  well.
Thanks
Bill

KP | LAW
*The Leader in Public Sector Law*

101 Arch Street, Boston, MA 02110
Tel: 617.556.0007 | Fax: 617.654.1735
**www.k-plaw.com**

March 9, 2022

**Lauren F. Goldberg**
lgoldberg@k-plaw.com

BY ELECTRONIC MAIL ONLY (DSchindler@hopedale-ma.gov)

Ms. Diana Schindler
Town Administrator
Hopedale Town Hall
P.O. Box 7
Hopedale, MA 01747

Re: Client Legal Matters

Dear Ms. Schindler:

This letter is to notify you that as of March 14, 2022, Attorney Jonathan M. Silverstein will no longer be practicing with the firm of KP Law, P.C. and will be joining the firm of Blatman, Bobrowski, Haverty & Silverstein, LLC. Be advised that established case law obligates a firm and a departing attorney to notify clients in writing of the change in their relationship before contacting the clients about the change. This letter serves as that notice.

As the client, you have the right to choose which attorney will handle such matters for you. You can choose to have Attorney Silverstein, KP Law, P.C., or other counsel, work on any or all of the items listed on the attachment, or on none of them, at your discretion. Attached please find a list of matters on which we have been representing you.

Should you choose to transfer any of the matters at issue to Attorney Silverstein or other counsel, arrangements will be made to transfer files in an efficient and timely manner so as to protect your interests in ongoing matters. In such case, please inform us in writing of any election you may make to transfer matters and specifically authorize the transfer of related files. For your convenience, the attached list of matters includes columns allowing you to indicate how you would like such matters to be handled, and completion of the same will constitute notice of any determination to transfer matters and authorization to transfer the related files.

Until a decision is made as described herein, the firm will continue to represent you with respect to the matters listed on the attachment, to ensure protection of your legal interests.

Very truly yours,

KP Law, P.C.

By: ____________________
Lauren F. Goldberg, President

Very truly yours,

____________________
Jonathan M. Silverstein

LFG/JMS/aem
803171/KP/0017

To: Lauren F. Goldberg, P.C.
KP Law, P.C.
101 Arch Street, 12th Floor
Boston, MA 02110
Fax: (617) 654-1735
lgoldberg@k-plaw.com

**TOWN OF HOPEDALE (13800)**

| **Matter Name** | **Transfer to Attorney Jonathan Silverstein** | **Remain with KP Law, P.C.** | **Transfer to New Counsel** |
|---|---|---|---|
| 75-131 Plain Street, LLC | ☐ | ☐ | ☐ |

Certification:

This is to inform you, in connection with your letter of March 9, 2022, that the above-completed document specifies those matters, if any, that the Client wishes to: transfer to Attorney Jonathan M. Silverstein, continue to be handled by KP Law, P.C. and/or, transfer to another counsel. If the Client has elected to have matter(s) transferred to a different counsel, that person or firm's name and address is set forth on this form or on a sheet physically attached hereto.

It is hereby recognized that return of this form to Attorney Goldberg, by regular mail, facsimile or e-mail, at the address or numbers specified above, will be shared with Attorney Silverstein or another named counsel, in the event another is named.

I certify by affixing my signature below that the appropriate appointing authority has taken the action specified herein, and if matters will be transferred to Attorney Silverstein or another named counsel, authorize the transfer of any files related to such matters to Attorney Silverstein or other counsel as specified.

Dated: ______________________________ Signed: ______________________________

187 Freedom Street, Hopedale, MA

**CONFIRMATORY DEED**

W.G.B. DEVELOPMENT CORPORATION (f/k/a W.G.B. Construction Co., Inc.), a Massachusetts corporation, with its principal place of business at 67 Cape Road, Mendon, Massachusetts 01756 (hereinafter "Grantor"),

in consideration of One Dollar ($1.00) paid, and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged,

grants to the TOWN OF HOPEDALE, a Massachusetts municipal corporation, acting by and through its Conservation Commission, pursuant to G.L. c. 40, §8C, having an address at 78 Hopedale Street, Hopedale, Massachusetts 01747 (hereinafter "Town"),

WITH QUITCLAIM COVENANTS

A certain parcel of unimproved land situated at 187 Freedom Street in Hopedale, Worcester County, Massachusetts being shown as "Open Space #4," containing 3.75 acres, more or less, on a plan entitled "'Pinecrest II' 'Definitive' Plan of Land in Hopedale, Mass.," dated November 3, 1987, prepared by Guerriere & Halnon, Inc., recorded with the Worcester South Registry of Deeds in Plan Book 593, Plan 111, to which plan reference is made for a more particular description.

Subject to the right of the Town of Hopedale to install a water tank and related appurtenances, including, but not limited to, pipes and conduits, on said property, as shown on the above referenced plan.

This transfer is made in the ordinary course of business and does not constitute all or substantially all of the assets of the Grantor in the Commonwealth of Massachusetts.

This is not homestead property of the Grantor.

Meaning and intending to convey and hereby conveying a portion of the premises conveyed to the Grantor by a deed recorded with said Registry in Book 8031, Page 14. This deed is intended to correct and confirm a deed by the Grantor to the Grantee dated December 23, 1992 and recorded in Book 15009, Page 353 in which the plan described in Parcel 8 of said deed incorrectly stated the reference to the plan for the subject property.

Executed as a sealed instrument this 11th day of February, 2022.

W.G.B. DEVELOPMENT CORPORATION,
f/k/a W.G.B. Construction Co., Inc.

By: ______________________
William G. Burrill, President and Treasurer

**COMMONWEALTH OF MASSACHUSETTS**

Worcester, ss.

On this 11th day of February, 2022 before me, the undersigned notary public, personally appeared William G. Burrill, President and Treasurer of W.G.B. Development Corporation, and proved to me through satisfactory evidence of identification, which was personally known, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he signed it voluntarily as his free act and deed for its stated purpose and as the free act and deed of W.G.B. Development Corporation.

Donna Lee Hurley
Notary Public Donna Lee Hurley
My Commission Expires: September 6, 2024

Donna Lee Hurley
NOTARY PUBLIC
Commonwealth of Massachusetts
My Commission Expires Sept. 6, 2024

## APPROVAL

The Town of Hopedale Select Board hereby approves the acceptance by the Hopedale Conservation Commission of a deed from W.G.B. Development Corporation for open space at 187 Freedom Street, Hopedale.

Executed as a sealed instrument this ______ day of ____________, 2022.

TOWN OF HOPEDALE,
By Its Select Board

______________________________
Brian Keyes, Chair

______________________________
Louis Arcudi, III, Member

______________________________
Glenda Hazard, Member

## COMMONWEALTH OF MASSACHUSETTS

WORCESTER, ss.

On this _____ day of ____________, 2022, before me, the undersigned notary public, personally appeared ______________________________________________, member of the Hopedale Select Board, proved to me through satisfactory evidence of identification, which was ☐ photographic identification with signature issued by a federal or state governmental agency, ☐ oath or affirmation of a credible witness, ☐ personal knowledge of the undersigned, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he/she/they signed it voluntarily for its stated purpose as member of the Select Board of the Town of Hopedale.

______________________________
Notary Public
My Commission Expires:

794775/HOPD/0147

**ACCEPTANCE**

The Town of Hopedale Conservation Commission hereby accepts a deed from W.G.B. Development Corporation for certain open space at 187 Freedom Street, Hopedale.

Executed as a sealed instrument this 25th day of March, 2022.

TOWN OF HOPEDALE,
By Its Conservation Commission

Becca Solomon, Chair

Marcia Mathews, Member

David Guglielmi, Member

**COMMONWEALTH OF MASSACHUSETTS**

WORCESTER, ss.

On this 25th day of March, 2022, before me, the undersigned notary public, personally appeared Becca Solomon, Marcia Matthews, David Guglielmi member of the Hopedale Conservation Commission, proved to me through satisfactory evidence of identification, which was ☐ photographic identification with signature issued by a federal or state governmental agency, ☐ oath or affirmation of a credible witness, ☒ personal knowledge of the undersigned, to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he/she/they signed it voluntarily for its stated purpose as member of the Conservation Commission of the Town of Hopedale.

Notary Public
My Commission Expires: March 15, 2024

Lisa Marie Pedroli
NOTARY PUBLIC
Commonwealth of Massachusetts
My Commission Expires Mar. 15, 2024

Hopedale Pond Dam

# WATER LEVEL CONTROL ALTERNATIVES EVALUATION

Town of Hopedale

February 2022

**FINAL**

Tighe&Bond

100% Recyclable

# Table of Contents





J:\H\H5025 Hopedale\002 - Freedom Street Dam\Report\Alternatives Analysis\Report Text.docx

# Section 1 Introduction

## 1.1 Background

Hopedale Pond is a centerpiece of the Town of Hopedale. The centrally-located waterbody provides significant scenic and recreational amenities for residents and is a much-loved resource. Water in the pond once provided manufacturing power, and later fire suppression water, for manufacturing in the adjacent Draper Corporation mill complex, where power looms were manufactured until the late 1970s. A site location map is presented in Appendix A.

Hopedale Pond Dam, also known as Freedom Street Dam, impounds Hopedale Pond. It is located at the southern end of the pond, carries Freedom Street on its crest, and abuts the Draper Mill complex, which was located on the downstream side until demolition of the buildings occurred in 2021. Hopedale Pond to the North and the mill complex properties to the south serve as barriers to vehicular and pedestrian access between the two sides of town, funneling people and vehicles into the narrow section of Freedom Street, including onto the bridge over the dam.

There is no sidewalk on the northerly, pond side, of Freedom Street. On the south side, there is a narrow sidewalk between the street and the building remnants. The sidewalk continues along the bridge over the dam's spillway. This section of sidewalk was constructed in 2016, replacing an older sidewalk. The old sidewalk was supported on steel posts, while the replacement sidewalk is a reinforced concrete beam, supported on the bridge piers.

The bridge is supported at each end by a concrete abutment and by four concrete piers located on the dam's spillway. The piers and abutments divide the spillway into five bays. Control of the water surface elevation in Hopedale Pond is established by the spillway crest but is raised through the installation of up to 3 feet of stoplogs, referred to alternatively as flashboards, on the downstream side of the spillway crest below the bridge and sidewalk. Construction of the replacement sidewalk has restricted access to the stoplogs from the catwalk located on the downstream edge of the spillway.

## 1.2 Study Scope

The Town of Hopedale retained Tighe & Bond to evaluate alternatives for the reconfiguration of the stoplogs at Hopedale Pond Dam. The evaluation includes the following tasks:

- Collection and review of existing available information
- Site visit to visually review existing conditions
- Hydrologic and hydraulic analysis to provide analytical context for the alternatives analyzed
- Analysis of the following three alternatives for reconfiguration of the dam's water control structures

  - Mounting stoplogs to the existing upstream piers of the bridge, similar to the design by Beta Group.
  - Adding stoplogs upstream of the bridge as a stand-alone structure.
  - Removing the catwalk on the downstream side of the spillway and adding stoplogs, slide gates, or a combination of the two

This work is not intended to serve as a bridge or dam inspection or conditions assessment, since those tasks are undertaken by others on a periodic basis, nor has a load rating analysis of the bridge been performed. This report relies on existing information provided by the owner and public information obtained from the Massachusetts Office of Dam Safety, as well as visual observations of accessible and above-water areas. No testing or new studies were performed as part of this work, with the exception of the hydrologic and hydraulic analysis. Only accessible areas of the bridge and dam were reviewed, underwater and subsurface areas were not viewed or evaluated.

## 1.3 Information Sources

The following information sources were used in the development of this alternatives analysis:

- Phase I Inspection Report, Hopedale Pond Dam. Army Corps of Engineers, 1979.
- Mass Highway Department Underwater Operations Team Routine Underwater Inspection Report, Bridge H-22-001, October 1, 2007.
- Application to Alter a Dam. Hopedale Pond Dam Repairs. Pare Corp. September 20, 2010.
- Dam repair photos from Town, ca. 2010.
- Freedom Street Over Mill River. Roadway and Bridge Rehabilitation. Drawing set of 14 sheets. Prepared by BETA, stamped July 13, 2016.
- Phase I Inspection Report, Hopedale Pond Dam. Lenard Engineering, Inc., 2017.
- Freedom Street over Hopedale Pond. Walkway Addition. Drawing set of 2 sheets. Prepared by BETA. Undated.

# Section 2
# Existing Conditions

## 2.1 Description of the Dam and Appurtenances

Right and left abutments are those on respective sides of an observer looking downstream. The following description of the dam and its appurtenant structures originated in the 2017 Phase I Inspection Report by Lenard Engineering, Inc and has been edited by Tighe & Bond. Photos showing the dam are provided in Appendix B.

The Hopedale Pond Dam is an earthen embankment with an overall length of approximately 300 feet, a maximum structural height of approximately 19.4 feet, and a hydraulic height of approximately 14.8 feet. A public roadway (Freedom Street) is located on the crest of the dam and the bridge spans over the spillway. The left upstream embankment is sloped at 2.5H:1V and is protected with stone rip rap along its lower half and grass vegetation along its top half. A short concrete wall retains a small portion of the upstream slope and is integral with the bridge's safety curb. The dam's left and right masonry downstream face is formed by the remnant foundation of the former factory building. The downstream wall at the spillway opening is stone masonry.

The primary spillway is located approximately 35 feet from the right abutment under Freedom Street. The spillway consists of five channels separated by four concrete piers. According to drawings entitled *Hopedale Pond Dam Spillway Repairs*, prepared by Pare Corporation, dated September 2010, the total spillway width is approximately 37.4 feet excluding the width of the concrete piers. A concrete apron extends from the upstream face of the spillway bed approximately 15 feet into the impoundment. In 2010, steel sheet piles were installed to form a new wall upstream of the rotted timber sheet pile wall at the spillway and the new upstream concrete apron was placed.

The five spillway channels flow under the dam crest (Freedom Street) and are divided into 10 bays formed by steel stoplog supports, and the stoplogs can provide up to three feet of weir height. The bays nearest to the left and right spillway abutments are approximately 5 feet wide while the interior bays are approximately 5-foot 8 inches wide. A concrete cap covers the spillway weir and is visible at the crest of the downstream masonry wall. The wall itself is formed by dry-laid battered stones. The toe is rip-rapped. Discharge continues through nine 6-foot wide, brick archways and a wide stone lined channel under the former factory complex building that was demolished in the summer of 2021. The invert from the toe of the downstream slope to the spillway crest was reported by Lenard to be approximately 14.5 feet.

The dam has three piped outlets, although only one is believed to be functional. Left of the spillway is the sluiceway that carries water from the pond to the low level outlet. The sluiceway is approximately 8 feet wide as measured between the two 8-foot-long upstream training walls and is reported as 7 feet 5 inches tall. It is unknown how the roadway is supported over the sluiceway. Wooden stoplogs and wooden stoplog supports at the inlet reportedly provide additional water level control, although these have been obscured by water levels.

Two outlets are reportedly fed by the sluiceway. The first outlet which serves as the pond drain is 5.5 feet wide by 4 feet high. The second outlet was reported to originally divert water through a turbine located in the factory building before discharging it back outside into the spillway channel. The Owner has reported that there are currently no existing controls inside or outside the turbine vicinity and that they were most likely removed during the Freedom Street bridge replacement in 1991 (note: Tighe & Bond has not found other references to this bridge replacement nor found drawings or as-built information). The remaining exterior boilerplate discharge pipe for the turbine can be seen at the left toe of the spillway. The low-level outlet and turbine outlets are controlled by operators located approximately 106 feet from the right abutment on the downstream side. The operating wheels are supported by a platform made from a steel plate secured to the stone masonry. The platform extends past the wall providing room for the two operating stems.

Right of the spillway is a structure that is approximately 7.5-foot square and was once intended to augment water supply during peak fire demands in the vicinity. The structure is located approximately 8 feet from the upstream face of the dam. The upstream side of the structure shares 20 feet of wall with a retaining wall for the impoundment. The fire demand outlet structure houses a 20-inch pipe of unknown material. A 20-inch pipe once extended upstream from the spillway but has since been removed. The outlet pipe was capped in 2010, so the outlet is no longer usable.

Freedom Street (a public way) lies on the crest and has a roadway width of approximately 25 feet. A 3-foot wide concrete sidewalk also lies on the crest along the downstream side of the roadway. The sidewalk consists of an integral concrete beam that supports a vehicular guardrail, and which inhibits removal of the dam's stoplogs. A 12-inch wide safety curb lies on the crest, along the upstream side of the roadway. A water pipeline is attached to the underside of the sidewalk deck and runs parallel with Freedom Street along the downstream side of the spillway and a gas main is located along the upstream side of the embankment and is supported by the bridge piers. Measurements for the clearance from the spillway crest to the bottom of the low chord of the bridge deck vary significantly in differing information sources (3 feet 10 inches to 4 feet reported by Beta; 4 feet 4 inches reported by Pare, 4 feet 2 inches measured by Tighe & Bond).

The 54.5-foot long wooden catwalk on the downstream side of the spillway begins approximately 28 feet from the right abutment. The 33-inch wide deck appears to be constructed of 2x4's. The catwalk is elevated over the spillway crest by approximately 5 feet. The walkway is founded on timber footings and timber bents. Each of the ten wooden bents is attached to one of the steel stoplog supports. The ends of the deck bear on top of the downstream concrete spillway training walls. The downstream ends of the spillway training walls were reconstructed in 2010.

## 2.2 Owner/Caretaker

The Massachusetts Office of Dam Safety lists the owner of the dam as Hopedale Properties, LLC. Tighe & Bond has not researched ownership. However, the 2017 Phase I Inspection report by Lenard Engineering Inc. reports ownership as follows:

> *The dam is owned jointly by the Town of Hopedale and Hopedale Properties. The property line is purportedly at the downstream edge of the sidewalk (on the downstream side): included in the Town's ownership are the upstream face, upstream spillway apron, upstream spillway channel, and upstream spillway training walls, low level inlet, the upstream portion of the low level channel, and low level*

*Inlet controls (stoplogs), earthen dam core, dam crest, the public way Freedom Street and vehicular bridge and pedestrian sidewalk over the spillway, and utility pipes hanging under the bridge; included in Hopedale Properties' ownership are the downstream portion of the spillway training walls, the downstream masonry face, dam controls (spillway stoplogs and low level outlet gates and wheels), the timber catwalk, the downstream raceway, and portions of the right upstream abutment which lie outside of the roadway layout (see Assessor's Map #8). Hopedale Properties has deeded water rights to the impoundment. First American Realty is the caretaker for the downstream mechanical components of the dam.*

## 2.3 Design and Construction Records

Design information for the 2010 dam repairs and 2016 spillway repairs are on-file with the Town of Hopedale. Limited construction records for the 2010 repair project were located. No information regarding the 1991 bridge replacement has been available to Tighe & Bond to review.

## 2.4 Dam Size and Hazard Classification

Hopedale Pond Dam has a maximum structural height of approximately 19.40 feet and a maximum storage capacity of approximately 990 acre-feet. Refer to Appendix D for definitions of height of dam and storage. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety Regulations of 302 CMR 10.00 Hopedale Pond Dam is considered an **Intermediate** size structure.

Hopedale Pond Dam is located in the Town Center upstream of homes and businesses. Hopedale Pond Dam is also located upstream of Mendon Street (Route 16) and the Hopedale wastewater treatment facility. It appears that a failure of the dam at maximum pool may cause loss of life and damage home(s), industrial or commercial facilities, secondary highways or railroads or cause interruption of use or service of relatively important facilities. Therefore, in accordance with Department of Conservation and Recreation regulations of 302 CMR 10.00, Hopedale Pond Dam is currently classified as a **Significant** hazard potential dam. The hazard potential of the dam should be revisited when the downstream area is redeveloped.

## 2.5 Previously-Reported Condition

Lenard Engineering Inc. performed a Phase I Inspection of Hopedale Pond Dam on July 18, 2017, finding the dam to be in Fair condition. The following deficiencies were identified:

- Brush/vegetation growing through riprap on the left upstream slope
- Exposed gravel on the upper portion of the left upstream slope
- Left upstream earthen slope is undulating and irregular
- Considerable clear colored seep through the left downstream stone masonry face
- Void at the base of the spillways right upstream wall
- Concrete spillway cap is eroded on the downstream edge
- Low level inlet concrete wingwalls (upstream) are deteriorated

- Upstream concrete wall to the left of the low-level outlet has fallen inward toward the impoundment
- The shared concrete wall between the low-level inlet and the spillway inlet has deteriorated.

Although Tighe & Bond did not perform its own inspection of the dam, the leakage through the left downstream stone masonry wall, in approximate line with the sluiceway for the low-level outlet, was discharging at a high rate of potentially dozens of gallons per minute at the time of our August 3, 2021 site visit.

# Section 3
# Field Evaluation

Tighe & Bond performed a field evaluation of Hopedale Pond Dam on August 3, 2021. At the time of the site visit, the Draper Mill building was partially demolished, which allowed the dam to be viewed from different perspectives on the downstream side. The underside of the bridge deck was not accessed, and water was flowing over the bridge and spillway floor by several inches, obscuring it from view. Representatives from the Town and mill building owner were present. Photos taken during the site visit and referenced herein are presented in Appendix B.

The visible portions of the original (late 19th century) downstream ashlar dam walls appear to have consistent vertical alignment and there was no obvious evidence of absent stones (Photos 2, 3, 5). However, in areas, particularly east of the spillway and downstream from the low-level outlet inlet, the masonry joints appeared to be large and open, apparently missing chinking stones. Loose pieces of mortar were observed in several areas, but mortar was absent from the majority of the wall. Leakage was discharging from the downstream face of the wall at a high rate, approximately in-line with the low-level outlet inlet (Photo 5).

Debris from the demolition of adjacent mill buildings has accumulated below the wall in the spillway. This debris along with the water discharging over the dam obscured the lower portion of the wall, such that it could not be assessed. The wooden walkway that provides access above the spillway edge (Photos 4 and 6) is in poor condition with many deck boards exhibiting significant rot. Several of the railing posts are poorly attached or completely detached at their bases.

It is not apparent visually, nor from the drawings available to review, how the bridge's intermediate piers or abutments are founded on the spillway, or if they pass through the spillway. A concrete slab was visible on the crest of the spillway on the downstream side. Drawings from the 1920s appear to show a beam present below the slab on the downstream face, but a beam was not visible in the field.

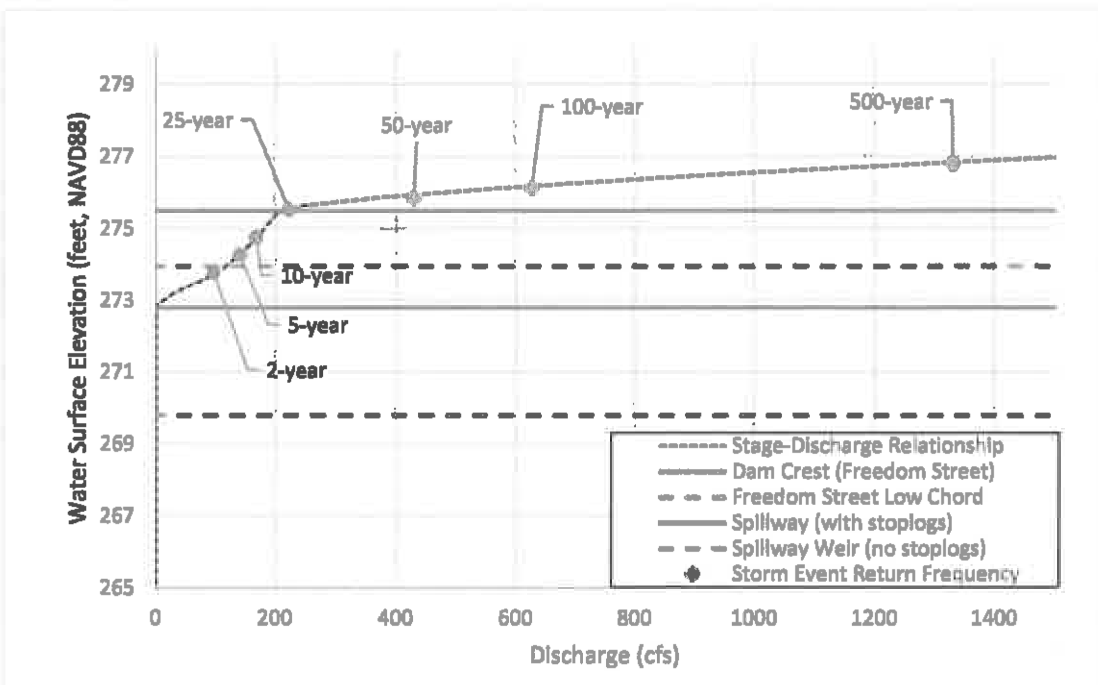
The apron upstream of the bridge was replaced approximately 11 years ago and is assumed to be in good condition, although it was obscured by the flowing water (Photo 9). According to information provided, during construction of the apron the pond was drained, and steel sheet piles were installed upstream of the structure. Flowable fill was used to fill undermined areas and the new concrete apron was poured between the sheet piles and the portion of the spillway under the bridge. The low-level inlet wingwalls have deteriorated substantially (Photo 11) as has the wall between the wingwalls and the spillway. The wall to the left of the low-level inlet has collapsed and fallen toward the impoundment. Some cracking of the bridge piers was visible above the water line, but the condition of their lowest portions could not be assessed due to the water level.

# Section 4
# Hydrology & Hydraulics

Tighe & Bond performed a hydrologic and hydraulic (H&H) analysis for Hopedale Pond Dam as part of this work. A report is presented in Appendix E. The purpose of the analysis is to review three alternatives, discussed further in Section 5, for replacement of the dam's stoplog system to improve operability and not for the purpose of evaluation of the dam's existing performance for regulatory purposes. The alternatives reviewed are as follows:

- Stop logs mounted on new structures built in the existing apron with pedestrian access bridge.
- Stop logs and slide gates mounted on upstream face of existing bridge piers.
- Stop logs mounted on the portion of the spillway downstream of the existing bridge piers.

Existing conditions were modelled as a basis for comparison. In summary, the model prepared suggests that the dam may currently have inadequate capacity to safely pass its Spillway Design Flood (SDF), which is the 100-year storm (dictated by the Massachusetts Dam Safety regulations based on the dam's size and hazard classification), when the dam's stoplogs are in-place. Existing H&H model results for Hopedale Pond Dam are presented in the following figure.




**Elevation-Discharge Relationship for Existing Conditions at Hopedale Pond Dam**

In this configuration, the Dam has the capacity to pass approximately 220 cfs without overtopping the dam crest. The spillway can pass the 2-, 5-, 10-, and 25-year frequency flood event without overtopping the dam crest; however, the spillway can only pass the

2-year storm event with approximately 0.2 feet of freeboard to the low-chord (i.e., the roof of opening through the bridge) at Freedom Street. The 100-year and 500-year flood event is expected to overtop the dam crest by approximately 0.6 feet and 1.3 feet, respectively. If a portion of the dam's stoplogs, of at least 15 feet in width, were removed to the elevation of the spillway, then the dam could safely pass the SDF with one foot of freeboard. It is important to note that these results do not consider the potential downstream hydraulic restrictions, which are changing with the demolition of the mill building; the results are more consistent with the building in its demolished state.

Each of the three alternatives reviewed improve the hydraulic performance of the dam in a stoplog-in state. The most favorable from a hydraulic perspective would be to relocate the stoplogs to the apron upstream of the bridge. The least favorable would be to face-mount the stoplogs to the bridge piers, although the hydraulics would still be improved compared to existing conditions.

# Section 5
# Alternatives Analysis

Tighe & Bond reviewed three alternatives for reconfiguring the Hopedale Pond Dam spillway crest controls to allow the restoration of the normal summertime water surface elevation. Alternatives considered include applicable technologies and alternative installation locations. The alternative locations were evaluated in terms of operability/accessibility, consistency with future public access accommodations, and cost.

## 5.1 Technologies

### 5.1.1 Technologies Considered

A wide variety of technologies are available that could be used to raise the controlled level of the impoundment. Most dams rely on one or more of several common technologies due to their simplicity and cost.

The existing **stoplog** system is representative of the simplest range of options. They consist of wooden boards that slide into steel channels supported by the spillway slab and which resist the overturning force of the applied water through the mechanical connection at the base of the supports. Operation includes manually sliding the boards out of the slots, which can require opening a gap in a lower stoplog to let the water level down slightly. Stoplogs can be easily replaced when they fail or are lost, but absorb water, becoming heavy, and can be cumbersome to remove. Shorter stoplog spans are preferred for reduced weight. Timber stoplogs can leak significantly between the boards and at the ends, particularly as they age. Although they are wood, they can last in service many years since wood decay is slow when completely saturated.

Wooden stoplogs in a fish ladder

Metal stoplogs in a channel

Manufactured stoplog systems are available that use designed channels and metal or fiberglass planks. They tend to seal better for longer periods and are easier to operate. Metal planks, particularly aluminum, are typical in surface water applications. Lifting hooks are available to ease removal. Disadvantages include difficulty of replacement following loss or damage and increased cost. Manufactured stoplogs are typically designed to be supported from the bottom and sides, so supporting stanchions are needed between stoplog bays.


Removal of stoplogs with a hoist

The existing boards at Hopedale Pond Dam are sometimes informally referred to as **flashboards.** Flashboards are similar to stoplogs but are designed to fall at a target water level. They typically consist of wooden planks supported by steel rods or pipes inserted into sleeves cast into the spillway crest. The supports consist of standard products that can be replaced easily. When the target water level is achieved, they bend over, releasing stored water opening the spillway to additional capacity. They are best applied when the area downstream is undeveloped since they cause a sudden rise in water levels downstream that may be dangerous. The Hopedale Pond Dam stoplogs were constructed as flashboards as shown in drawings from the 1920s (included in the Army Corps of Engineers Phase I report), although they appear to have been converted to stoplogs since they currently have more rigid supports that appear less likely to fall under periodic loading conditions. Flashboards were not considered further given their potentially dangerous drawbacks.


Leaning and deteriorated flashboards

**Slide gates** work under the same principal as stoplogs, in that the crest can work as a weir, except the entire gate panel is lifted as one unit rather than removing individual plants. A crank or handwheel provides mechanical advantage and should be positioned for ease of access. They are simpler to operate than stoplogs

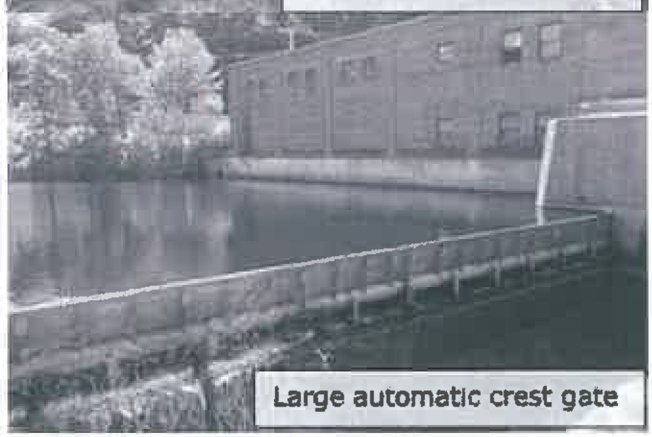

Slide gate with catwalk and operator

but require more attention when throttled, since, when opened, the water passes underneath, instead of over the weir. If the operator intends to lower the water level partially, then it is necessary to regularly adjust the gate up or down to account for changes in flow conditions. Slide gates work best when their aspect ratio is low; if they are much wider than they are tall, they can become jammed if they twist slightly in the frame. Similar to stoplogs, slide gates are designed to be supported at their base and along their sides.

### 5.1.2 Specialty Equipment – Not Considered

Other equipment approaches exist for use in more unique applications. **Crest gates** are an improvement on the flashboard technology; they are typically large metal panels, typically steel, that are hinged at the base and pivot up and down to raise and lower the water level. They can be manually or automatically operated. They work well at high aspect ratios, when their width is large relative to their height. However, they require more front-to-back room to accommodate their pivoting motion, and their larger size mean that significantly more force is required for operation, so hydraulic operation is typically preferred, and the supporting requirements are significant. Since they are a flow-over technology, they can be partially raised or lowered to allow for fine water level adjustment. Several crest gates in Massachusetts are operated by a control system that raises and lowers the gate in response to changes in water level in an effort to keep consistent water levels. The use of a crest gate would likely add tens to hundreds of thousands of dollars to the project cost, so this technology was not considered.

Small, manual crest gate



Large automatic crest gate

Inflatable bladders, referred to as **rubber dams**, are sometimes used in place of crest gates, particularly for very wide spillways. Their mechanical requirements are significantly lower than crest gates, but they require significant geometric modifications to spillways to accommodate their installation. In addition; they cannot be throttled. If the air pressure is reduced, they may collapse in areas as they partially deflate, lowering the water level more than intended.

Other technologies are available, varying by application and advantages, but do not provide significant benefits over the options mentioned above for this site.

## 5.2 Alternative Configurations

Tighe & Bond considered three alternative configurations, discussed below. Conceptual sketches for the alternatives are provided in Appendix C and Conceptual Opinions of Probable Cost are provided in Appendix D. It is important to note that the dam requires other repairs beyond what is included in the sketches and Opinions of Probable Cost.

It is important to note that the design approach and costs may vary, potentially significantly, as more information is gained as the project proceeds and as the bidding environment changes.

### 5.2.1 Alternative 1 – Stop logs mounted on new structures built in the existing apron with pedestrian access bridge.

Alternative 1 includes mounting stop logs on the existing apron upstream of the existing bridge opening. New supporting structures, such as small piers, would need to be constructed to sufficiently restrain the stoplogs. At this location, the stoplogs could not be operated from Freedom Street because of the distance. There may be sufficient room for placement of a pedestrian bridge crossing of Hopedale Pond upstream from the proposed stoplogs that could also serve to provide access to the stoplogs using a lifting apparatus from above, although operation may still be cumbersome.

To further aid operation, slide gates could be used in combination with stoplogs, or in place of them, with the slide gate operator(s) placed at a height that would be operable from the footbridge. Since the fire demand outlet structure at the right side of the spillway is no longer needed, it could be demolished and replaced with a pier for the pedestrian bridge on that end. A new pier would need to be added left of the left outlet structure to support the footbridge on that end, and the exposed gas main and bridge rail along the upstream edge of the dam crest would be obstacles requiring further considerations for rejoining the road with the path leading to the bridge; a boardwalk could potentially be added along the upstream slope of the dam to the bring the path closer to Hopedale Street.

Construction of this alternative would also require repairs to the wall that separates the spillway from the left outlet structure, since the existing wall is badly deteriorated and since the wall would serve as the end of the replacement stoplogs (note that the outlet also requires more significant repairs as discussed in Section 3.

As discussed in Section 4, this alternative provides the largest spillway capacity with the stoplogs in place given the distance between the stoplogs and the Freedom Street bridge. Construction of the pedestrian bridge above the 100-year flood elevation would be preferable so that it would not become a restriction or trap debris. However, at that elevation, it will be higher than Freedom Street itself and would block the view of the pond from the road, which is an aesthetic disadvantage.

Alternative 1 has several permitting and design advantages:

- It provides dam safety benefits since it increases the dam's hydraulic capacity compared to existing conditions, so it may be viewed favorably during the dam safety permitting process.

- It imposes no new loads on the Freedom Street Bridge, so MassDOT bridge review coordination may be straightforward or unneeded.
- The work involves components of the dam where construction occurred recently, with design and limited construction information available, so there may be a lower risk of unforeseen conditions during construction.

However, Alternative 1 imposes an environmental permitting challenge, although not insurmountable:

- Piers for the footbridge occupy volume within Bordering Land Subject to Flooding (BLSF) which may need to be mitigated for. However, in similar situations the hydraulic benefits from changes in spillway configuration have been shown to more than offset the loss in BLSF storage.

### 5.2.2 Alternative 2 – Stop logs and slide gates mounted on upstream face of existing bridge piers

Alternative 2 has different possible configurations two of which were considered qualitatively and for which are presented opinions of probable cost. Both options use the existing bridge piers as support structures for new water-level control devices. The first configuration, Configuration A, includes slide gates on a limited number of the spillway openings, with stop logs filling the remaining bays. The intended operating procedure for this configuration would be to lower the pond level using the slide gates, then to access the stop logs from the spillway apron, walking through the shallow water.

Configuration B uses only stop logs in all bays and provides a small bridge or catwalk for workers to access them. This catwalk/bridge would not be open to the public and would terminate at a new pier built in the pond. This is similar to the configuration previously designed by Beta Group and presented to the Town.

Configuration A would likely require intermediate supports to be added between the bridge piers to support slide gates. The intermediate piers would also be helpful in a stoplog-only configuration to reduce the stoplog weight, easing operability for personnel. However, these intermediate piers would reduce the outlet capacity in its stoplog-out configuration since they would occupy the open area between bridge piers.

Configuration A provides some operational advantages to Configuration B since the slide gates could be more easily opened in advance of a storm. However, accessing the remaining stoplogs would be more difficult, and the gate operator would be a long reach from the existing Freedom Street bridge, so operation may be slow or clumsy. The catwalk or bridge proposed for Configuration B would significantly restrict hydraulic capacity beyond what is predicted by the hydraulic models presented in Section 4 given that it would likely not be located above the 100-year storm elevation.

Either configuration of Alternative 2 has environmental permitting advantages, since the work would occur only on the existing dam structure and would not significantly affect wetland resource areas.

However, the alternative is least advantageous of the three alternatives reviewed from a hydraulic perspective, which means less advantageous from a resiliency perspective, and would be more difficult to justify during the dam safety permitting process. Alternative 2 would impose additional loadings on the bridge piers, and Tighe & Bond did not find information regarding the interaction between the piers and the spillway weir during the preparation of this report. Significant additional investigation may be required to satisfy MassDOT bridge review requirements.

### 5.2.3 Alternative 3 – Stop logs mounted on the portion of the spillway downstream of the existing bridge piers

Alternative 3 consists of mounting the proposed stop logs on new concrete posts constructed on the portion of the spillway downstream of the existing piers. The existing wooden walkway would be demolished, and the stop logs would be accessed from the sidewalk of the Freedom St Bridge. Sluice gates could be used in lieu of or in combination with stoplogs, with the operating wheels controlled from the sidewalk. Removal of stoplogs from the Freedom Street bridge would be a challenging operation, potentially involving a lifting apparatus manipulated by machinery, such as a backhoe, with personnel guiding the lifting apparatus with ropes attached to either end. There would likely not be sufficient room to add a catwalk near enough to the stoplogs to allow direct personnel access. The use of sluice gates operated from the existing sidewalk would address the stoplog access challenges.

This alternative would change the loading on the dam crest slightly, and the thickness and reinforcement of the concrete overlay on the spillway weir is unknown. For this reason, it would be necessary to demolish a portion of the downstream edge of the spillway crest and replace it with reinforced concrete to provide sufficient mass to resist the overturning and sliding of the stoplogs or sluice gates.

Although this alternative is not as favorable from a hydraulic perspective as Alternative 1, it provides an improvement compared to existing conditions and provides better performance than Alternative 2. As such, it could be acceptable to the Office of Dam Safety, and the relative ease of operation of this alternative with sluice gates included would also mean that the impoundment could be easily drawn down in advance of a large forecasted storm. This alternative also constrains the site less than other alternatives, so there is more flexibility for the Town in development of future improved pedestrian accessibility options.

From a permitted perspective, this alternative will involve less MassDOT review than Alternative 2 (potentially none) and should be straightforward from an environmental permitting perspective since the resource area impacts are low.

# Section 6
# Recommendations

Tighe & Bond recommends Alternative 3 with a combination of stoplogs and sluice gates as it best addresses the Town's goals of returning the water level to normal. This alternative involves little impact to the existing bridge, improved hydraulics compared to existing conditions, relatively convenient operation without the addition of costly access infrastructure and leaves more flexibility for the addition of future pedestrian access improvements.

Tighe & Bond further recommends that the Town and dam owner consider expansion of the project to address the dam's other deficiencies, since performing the rehabilitation as part of one project would be less costly in the long term than implementation of the water control improvements and performing other repairs as part of separate projects. Obtaining outside funding sources for the water control improvements alone may be challenging, but implementing other repairs along with the water control improvements may open the project to funding under the Massachusetts Dam and Seawall Repair and Removal Fund, which provides grants to municipal and non-profit entities for dam improvements (25% match required).

Relative to the water control improvements alone, Tighe & Bond recommends the following implementation pathway:

- Perform site survey and wetland delineation to prepare a base map and better understand wetland resource area boundaries.
- Use the hydraulic model developed as part of this project to determine the appropriate number of sluicegates to provide adequate hydraulic control.
- Verify sluice gate design and operational reach with equipment manufacturers.
- Design modifications to downstream edge of spillway crest and design spillway supports.
- Obtain required dam safety and environmental permits
- Prepare bidding drawings and specifications.

If the implementation of other dam repairs are to be considered, additional investigation is recommended, primarily of the extent of the deficiencies related to the left outlet structure.

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**Appendix A**
**Site Location Figure**


## Legend

★ Hopedale Pond Dam

Town Boundary

1:12,000 1 in = 1,000 ft

0 500 1,000

Feet

N

Tighe&Bond

Engineers | Environmental Specialists

Based on MassGIS Color Orthophotography (2019)

**FIGURE 1**
**ORTHOPHOTOGRAPH**

Hopedale Pond Dam
Hopedale, Massachusetts
MA00624

May 2021

H-5025

# Appendix B
# Site Photographs

**Photo 1 – Overview of bridge and dam from upstream**

**Photo 2 – Overview of spillway from downstream showing existing catwalk**

**Photo 3 – Right end of spillway weir and bridge abutment from downstream**

**Photo 4 – View through Freedom Street bridge opening from downstream; note insulated water main; existing stoplog supports indicated with arrow; note debris within opening**

**Photo 5 – Left outlet gate operator stems; note leakage through wall and missing mortar throughout wall**

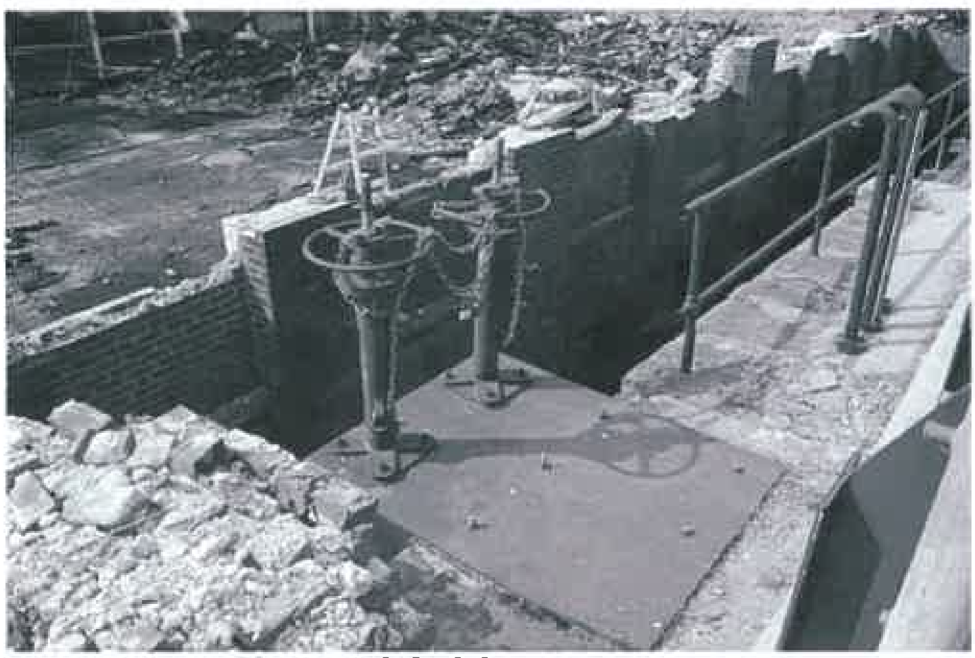


**Photo 6 – left sluice gate operators**

**Photo 7 – Existing catwalk and sidewalk**

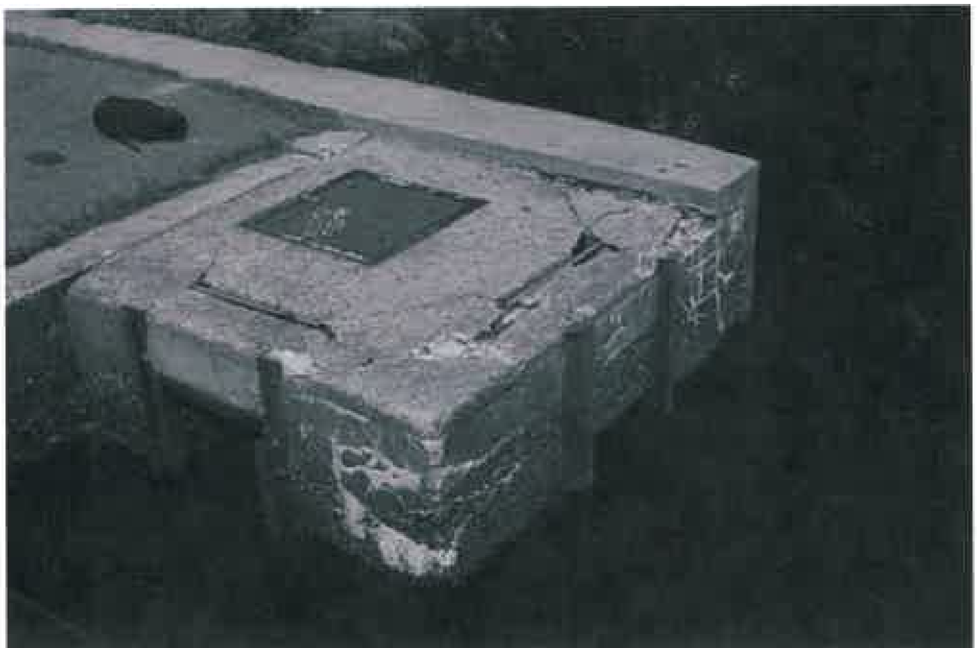


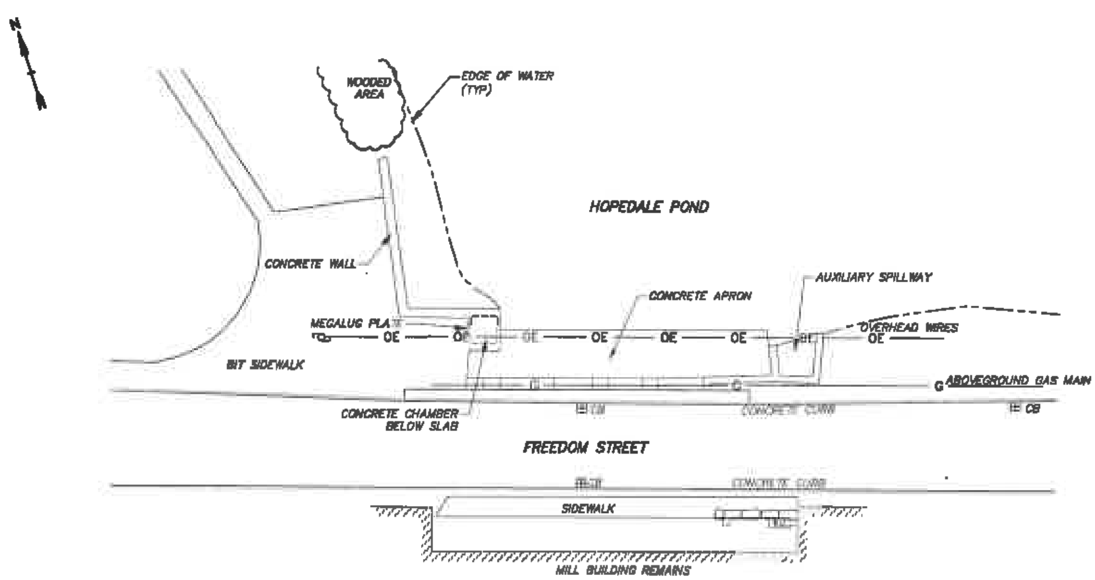
**Photo 8 – Overview of right outlet structure; no longer functional**

**Photo 9 –Bridge from upstream, showing one opening and gas main**

**Photo 10 – Overview of bridge and dam from upstream; left outlet is in foreground**

**Photo 11 – Left outlet inlet**

# Appendix C
# Conceptual Sketches




**NOTES:**

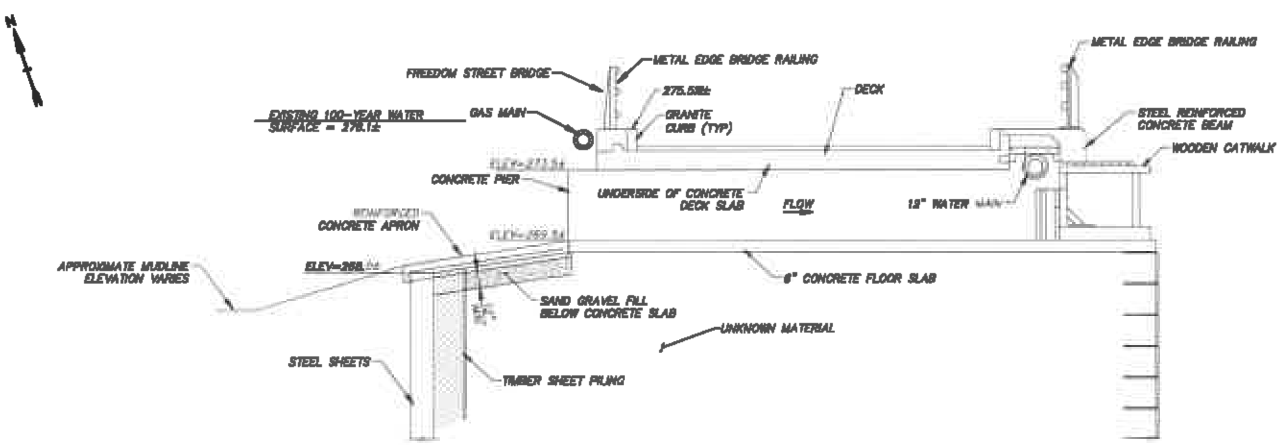
1. EXISTING FEATURES ARE DRAWN FROM A PDF DRAWINGS TITLED "HOPEDALE POND DAM SPILLWAY REPAIRS" DATED SEPTEMBER 2010 BY PARE CORPORATION, ENGINEERS- SCIENTISTS- PLANNERS, 10 LINCOLN ROAD SUITE 103, FOXBORO, MASSACHUSETTS AND A PDF OF DRAWINGS TITLED "FREEDOM STREET OVER MILL RIVER ROADWAY AND BRIDGE REHABILITATION" DATED JUNE 2016 BY BETA, INC. NO RECORD DRAWINGS WERE AVAILABLE.

EXISTING SITE PLAN

ALTERNATE ANALYSIS
HOPEDALE POND DAM
HOPEDALE, MASSACHUSETTS
DAM NO. MA00624

DATE: 11/2021
SCALE:
BY: DRB

Tighe&Bond
www.tighebond.com




## SECTION

**NOTES:**

1. EXISTING FEATURES ARE DRAWN FROM A PDF DRAWINGS TITLED "HOPEDALE POND DAM SPILLWAY REPAIRS" DATED SEPTEMBER 2010 BY PARE CORPORATION, ENGINEERS- SCIENTISTS- PLANNERS, 10 LINCOLN ROAD SUITE 103, FOXBORO, MASSACHUSETTS AND A PDF OF DRAWINGS TITLED "FREEDOM STREET OVER MILL RIVER ROADWAY AND BRIDGE REHABILITATION" DATED JUNE 2016 BY BETA, INC. NO RECORD DRAWINGS WERE AVAILABLE.

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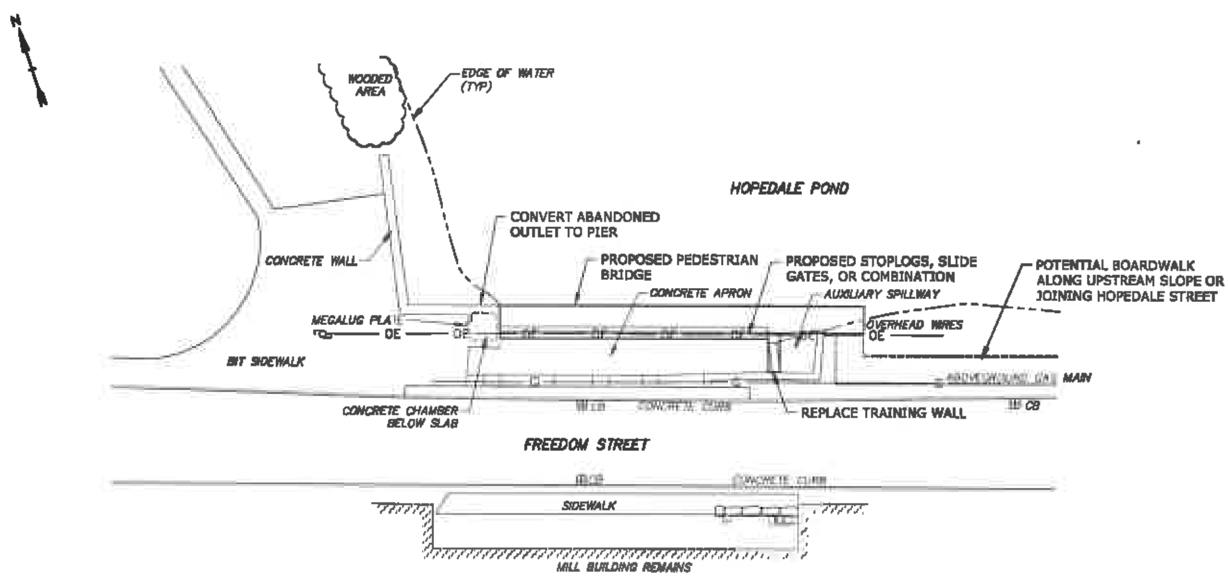
|---|---|
| EXISTING SECTION | |
| ALTERNATE ANALYSIS<br>HOPEDALE POND DAM<br>HOPEDALE, MASSACHUSETTS<br>DAM NO. MA00624 | |
| DATE: 11/2021 | Tighe&Bond |
| SCALE: AS SHOWN | www.tighebond.com |
| BY: DRB | |

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ALTERNATIVE 1 SITE PLAN

ALTERNATE ANALYSIS
HOPEDALE POND DAM
HOPEDALE, MASSACHUSETTS
DAM NO. MA00624

DATE: 11/2021
SCALE: ........
BY: DRB

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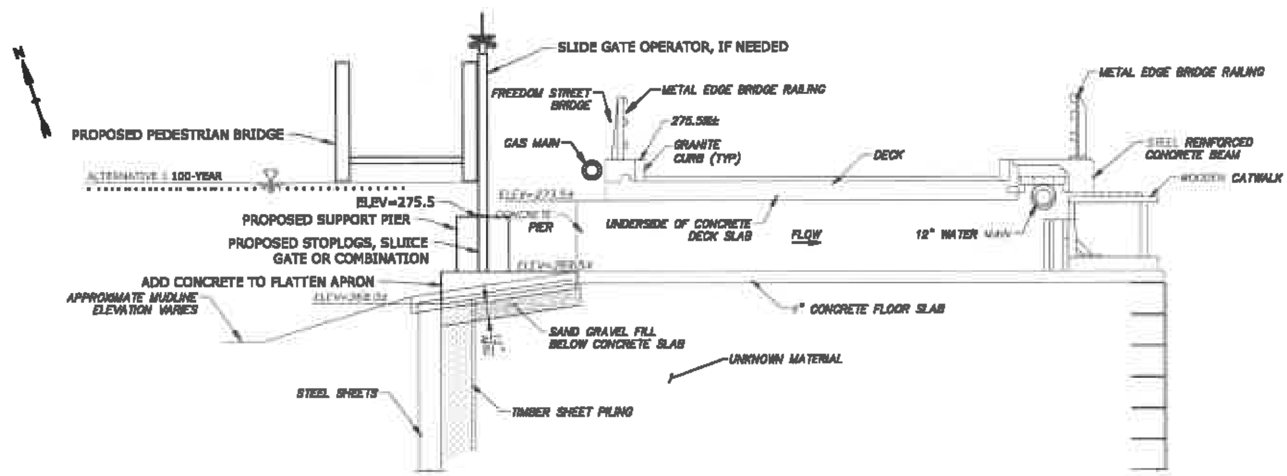


SECTION

**NOTES:**

1. EXISTING FEATURES ARE DRAWN FROM A PDF DRAWINGS TITLED "HOPEDALE POND DAM SPILLWAY REPAIRS" DATED SEPTEMBER 2010 BY PARE CORPORATION, ENGINEERS- SCIENTISTS- PLANNERS, 10 LINCOLN ROAD SUITE 103, FOXBORO, MASSACHUSETTS AND A PDF OF DRAWINGS TITLED "FREEDOM STREET OVER MILL RIVER ROADWAY AND BRIDGE REHABILITATION" DATED JUNE 2016 BY BETA, INC. NO RECORD DRAWINGS WERE AVAILABLE.

ALTERNATIVE 1 SECTION

ALTERNATE ANALYSIS
HOPEDALE POND DAM
HOPEDALE, MASSACHUSETTS
DAM NO. MA00624

DATE: 11/2021
SCALE: AS SHOWN
BY: DRB

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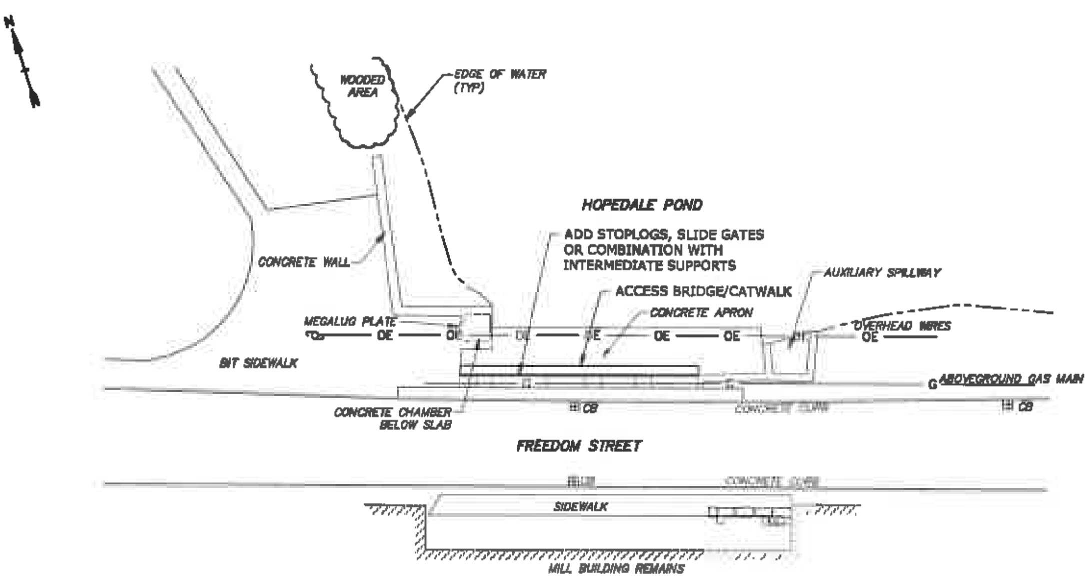


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ALTERNATIVE 2 SITE PLAN

ALTERNATE ANALYSIS
HOPEDALE POND DAM
HOPEDALE, MASSACHUSETTS
DAM NO. MA00624

DATE: 11/2021
SCALE:
BY: DRB

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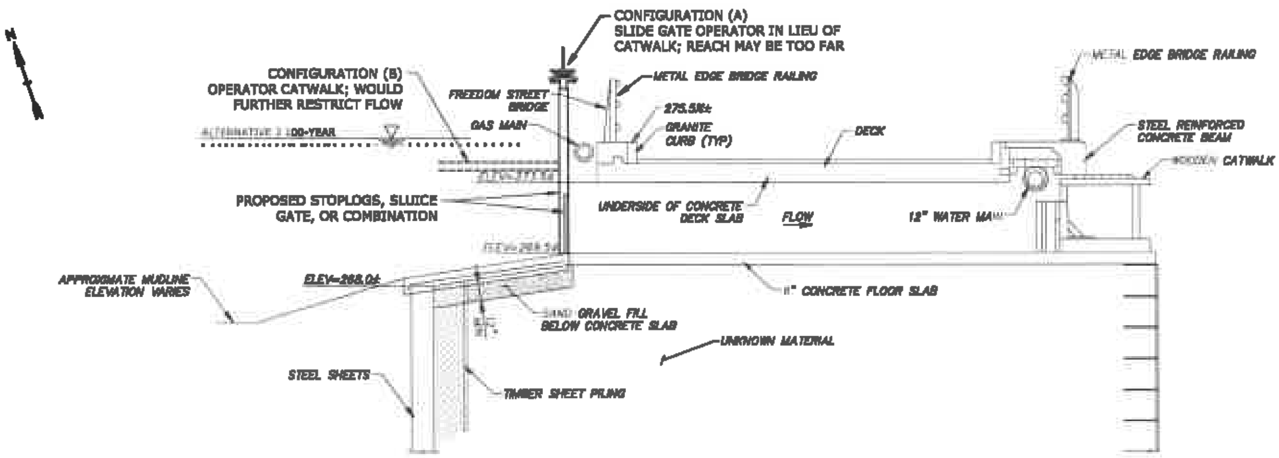


## SECTION

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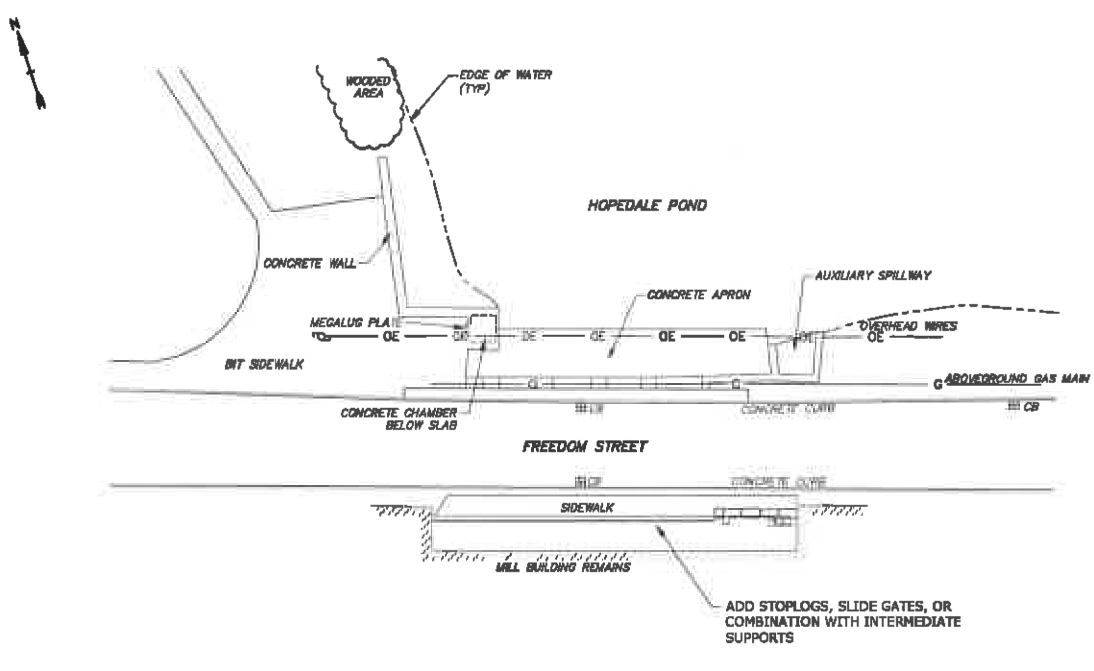
| ALTERNATIVE 2 SECTION | |
|---|---|
| ALTERNATE ANALYSIS<br>HOPEDALE POND DAM<br>HOPEDALE, MASSACHUSETTS<br>DAM NO. MA00624 | |
| DATE: 11/2021<br>SCALE: AS SHOWN<br>BY: DRB | Tighe&Bond |

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**ALTERNATIVE 3 SITE PLAN**

ALTERNATE ANALYSIS
HOPEDALE POND DAM
HOPEDALE, MASSACHUSETTS
DAM NO. MA00624

DATE: 11/2021
SCALE:
BY: DRB

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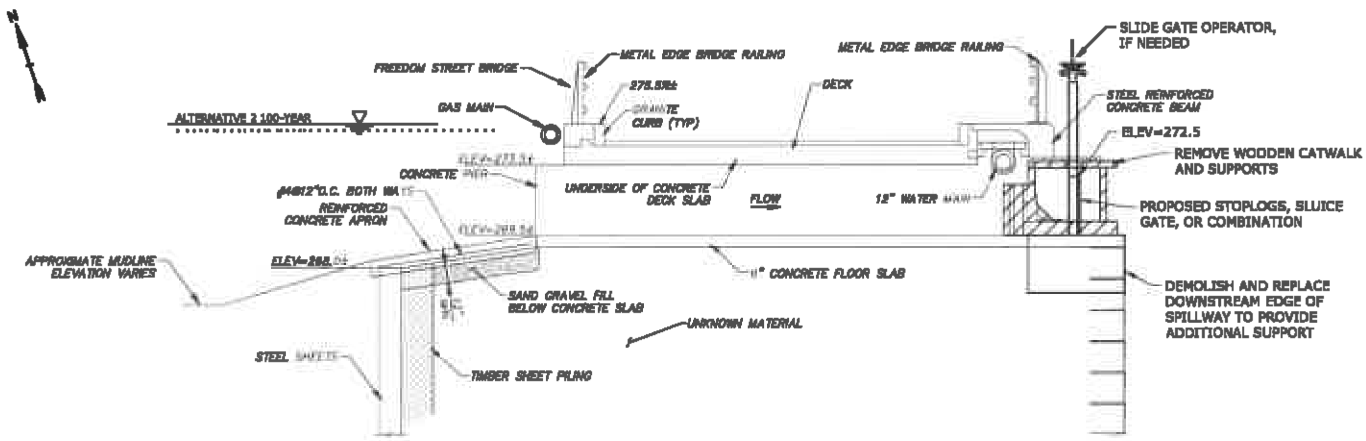


## SECTION

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ALTERNATIVE 3 SECTION

ALTERNATE ANALYSIS
HOPEDALE POND DAM
HOPEDALE, MASSACHUSETTS
DAM NO. MA00624

DATE: 11/2021
SCALE: AS SHOWN
BY: DRB

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# Appendix D
# Opinions of Probable Cost

## Conceptual Opinion of Probable Construction Cost

## Hopedale Pond Water Level Restoration Alternative 1

## Hopedale, MA

**Summary - Stop logs mounted to new structures founded upstream of existing bridge. An adjacent pedestrian bridge will provide access. Four sluice gates are assumed. The pedestrian bridge will terminate at the east side of the spillway; pedestrian connection to road is not included.**

| ITEM | DESCRIPTION | UNITS | QTY | UNIT PRICE | TOTAL |
|---|---|---|---|---|---|
| 1. | **General Conditions** | | | | |
| | Mobilization/Demobilization | LS | 10% | | $58,250 |
| | Contractors OH & P | LS | 15% | | $87,375 |
| 2. | **Site work** | | | | |
| | Dewatering | LS | 1 | $65,000 | $65,000 |
| | Excavation | CY | 45 | $100 | $4,500 |
| | Landscaping | LS | 1 | $5,000 | $5,000 |
| | | | | | **$74,500** |
| 4. | **New concrete** | | | | |
| | Bridge abutments | CY | 40 | $3,500 | $140,000 |
| | Square posts for mounting stop logs | CY | 9 | $3,500 | $31,500 |
| | Levelling course | CY | 8 | $3,500 | $28,000 |
| | | | | | **$199,500** |
| 5. | **Quoted bridge and stop logs** | | | | |
| | Bridge Brothers 80' bridge | LS | 1 | $192,500 | $192,500 |
| | Installation (+15%) | % | 15% | | $28,875 |
| | Crane | LS | 1 | $5,000 | $5,000 |
| | **Stop logs** | | | | |
| | Stainless steel angle | LF | 90 | $100 | $9,000 |
| | Pressure treated 4x4 | LF | 463 | $5 | $2,400 |
| | Sluice Gates | EA | 4 | $15,000 | $60,000 |
| | Installation/fabrication (+15%) | % | 15% | | $10,710 |
| | | | | | **$308,500** |
| | | | | SUBTOTAL | $728,100 |
| | Contingency | | | 40% | $291,240 |
| | | | | **CONSTRUCTION COST** | **$1,019,340** |
| | Engineering & Permitting | | | 35% | $356,769 |
| | | | | **TOTAL PROJECT COST** | **$1,377,000** |

**This is an engineer's Opinion of probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of the Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.**

**Conceptual Opinion of Probable Construction Cost**

**Hopedale Pond Water Level Restoration Alternative 2A**

**Hopedale, MA**

**Summary - Stop logs and sluice gates mounted to upstream face of existing bridge piers with spans split by new support structures. Four sluice gates on one end accessible from existing bridge.**

| ITEM | DESCRIPTION | UNITS | QTY | UNIT PRICE | TOTAL |
|---|---|---|---|---|---|
| 1. | **General Conditions** | | | | |
| | Mobilization/Demobilization | LS | 10% | | $23,440 |
| | Contractors OH & P | LS | 15% | | $35,160 |
| 2. | **Site work** | | | | |
| | Dewatering | LS | 1 | $65,000 | $65,000 |
| | Excavation | CY | 4 | $500 | $2,000 |
| | | | | | **$67,000** |
| 3. | **Concrete repairs** | | | | |
| | Crack and spall repairs on bridge piers and abutments | | | | |
| | Concrete Demo 0- 4" in Depth | SF | 100 | $50 | $5,000 |
| | Surface repairs | SF | 100 | $125 | $12,500 |
| | | | | | **$17,500** |
| 4. | **New concrete** | | | | |
| | Intermediate bearing posts between piers 1 yd concrete each | EA | 4 | $3,500 | $14,000 |
| | Foundations for piers | CY | 10 | $3,500 | $35,000 |
| | | | | | **$49,000** |
| 5. | **Stop logs and sluice gate** | | | | |
| | Stainless steel channel | LF | 45 | $250 | $11,250.00 |
| | Stainless steel angle | LF | 48 | $100 | $4,800.00 |
| | Pressure treated 4x4 | LF | 310 | $5 | $1,600.00 |
| | Sluice gates | EA | 4 | $15,000 | $60,000 |
| | Fabrication/Installation (+30%) | % | 30% | | $23,295 |
| | | | | | **$100,900** |
| | | | | SUBTOTAL | $293,000 |
| | Contingency | | | 40% | $117,200 |
| | | | | **CONSTRUCTION COST** | **$410,200** |
| | Engineering & Permitting (Incl. MassDOT Coordination) | | | 40% | $164,080 |
| | | | | **TOTAL PROJECT COST** | **$575,000** |

**This is an engineer's Opinion of probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of the Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.**

**Conceptual Opinion of Probable Construction Cost**

**Hopedale Pond Water Level Restoration Alternative 2B**

**Hopedale, MA**

**Summary - Stop logs mounted to upstream face of existing bridge piers with spans split by new support structures. A small access bridge upstream of the stop logs is provided.**

| ITEM | DESCRIPTION | UNITS | QTY | UNIT PRICE | TOTAL |
|---|---|---|---|---|---|
| 1. | **General Conditions** | | | | |
| | Mobilization/Demobilization | LS | 10% | | $35,330 |
| | Contractors OH & P | LS | 15% | | $52,995 |
| 2. | **Site work** | | | | |
| | Dewatering | LS | 1 | $65,000 | $65,000 |
| | Excavation | CY | 50 | $100 | $5,000 |
| | | | | | **$70,000** |
| 3. | **Concrete repairs** | | | | |
| | Crack and spall repairs on bridge piers and abutments | | | | |
| | Concrete Demo 0- 4" In Depth | SF | 100 | $50 | $5,000 |
| | Surface repairs | SF | 100 | $125 | $12,500 |
| | | | | | **$17,500** |
| 4. | **New concrete** | | | | |
| | Intermediate bearing posts between piers 1 yd conrete each | EA | 4 | $3,500 | $14,000 |
| | Foundations for piers | CY | 10 | $3,500 | $35,000 |
| | Access catwalk abutments | CY | 20 | $3,500 | $70,000 |
| | | | | | **$119,000** |
| 5. | **Stop logs** | | | | |
| | Stainless steel channel | LF | 45 | $250 | $11,250 |
| | Stainless steel angle | LF | 40 | $100 | $4,000 |
| | Pressure treated 4x4 | LF | 463 | $5 | $2,400 |
| | Access bridge/catwalk | EA | 1 | $105,000 | $105,000 |
| | Crane | LS | 1 | $5,000 | $5,000 |
| | Fabrication/Installation (+15%) | % | 15% | | $19,148 |
| | | | | | **$146,800** |
| | | | | SUBTOTAL | $441,600 |
| | Contingency | | | 40% | $176,640 |
| | | | | **CONSTRUCTION COST** | **$618,240** |
| | Engineering & Permitting (Incl. MassDOT Coordination) | | | 40% | $247,296 |
| | | | | **TOTAL PROJECT COST** | **$866,000** |

**This is an engineer's Opinion of probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of the Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.**

**Conceptual Opinion of Probable Construction Cost**

**Hopedale Pond Water Level Restoration Alternative 3**

**Hopedale, MA**

**Summary - Addition of stoplogs and sluicegates downstream of existing bridge, with sluice gate operators from bridge**

| ITEM | DESCRIPTION | UNITS | QTY | UNIT PRICE | TOTAL |
|---|---|---|---|---|---|
| 1. | **General Conditions** | | | | |
| | Mobilization/Demobilization | LS | 10% | | $22,710 |
| | Contractors OH & P | LS | 15% | | $34,065 |
| 2. | **Site work** | | | | |
| | Dewatering | LS | 1 | $65,000 | $65,000 |
| | Excavation | CY | 10 | $750 | $7,500 |
| | | | | | **$72,500** |
| 4. | **New concrete** | | | | |
| | Demolition of existion spillway | LS | 1 | $10,000 | $10,000 |
| | Replacement of downstream portion of spillway | CY | 20 | $3,500 | $70,000 |
| | Posts for stop logs | EA | 9 | $3,500 | $31,500 |
| | | | | | **$111,500** |
| 5. | **Stop logs** | | | | |
| | Stainless steel angle | LF | 60 | $100 | $6,000 |
| | Pressure treated 4x4 | LF | 300 | $5 | $1,500 |
| | Sluice gates | EA | 2 | $15,000 | $30,000 |
| | Installation (+15%) | % | 15% | | $5,625 |
| | | | | | **$43,100** |
| | | | | SUBTOTAL | $283,900 |
| | Contingency | | | 40% | $113,560 |
| | | | | **CONSTRUCTION COST** | **$397,460** |
| | Engineering & Permitting | | | 35% | $139,111 |
| | | | | **TOTAL PROJECT COST** | **$537,000** |

**This is an engineer's Opinion of probable Construction Cost (OPCC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, market conditions or the Contractor's method of pricing, and that the estimates of probable construction costs are made on the basis of the Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this estimate of the Probable Construction Cost.**

# Appendix E
# H&H Report

# Hopedale Pond Dam Hydrologic & Hydraulic Evaluation

**TO:** Diana M. Schindler

**FROM:** Christina Wu, David L. Azinheira, PE, Daniel R. Buttrick, PE

**COPY:**

**DATE:** November 21, 2021

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Tighe & Bond performed a hydrologic and hydraulic (H&H) analysis for Hopedale Pond Dam (MA00624) in Hopedale, Massachusetts. The purpose of the analysis is to review alternatives for adjusting the dam's stoplog system to improve operability and not to perform a detailed analysis of the dam's hydraulic capacity. A description of the analysis, the results, and our recommendations regarding next steps are provided below.

# 1 Description of Dam

Hopedale Pond Dam impounds the Mill River at Hopedale Pond for recreation and backup fire protection purposes. The dam is an approximately 265-foot long earthen embankment dam (estimated based on aerial imagery) with the dam crest carrying a public roadway (Freedom Street) and bridge located over the spillway weir. The date of dam construction is unknown although previous reports have indicated that the spillway and downstream area was modified in 1928. The upstream concrete approach apron and upstream sheet pile were replaced in 2010, and a roadway repairs/improvement was performed in 2016. The 2016 roadway work included repaving, new granite curbing, and installing a widened sidewalk on the downstream side of the dam. The new sidewalk prevents safe access to the stoplogs located on the downstream side of Freedom Street, thus inhibiting the ability to safely control the dam's water level.

The spillway consists of five channels separated by four concrete piers. According to drawings entitled Hopedale Pond Dam Spillway Repairs, prepared by Pare Corporation, dated September 2010, the total spillway width is approximately 37.4 feet excluding the width of the concrete piers. The five spillway channels flow under the dam crest (Freedom Street) and are divided into 10 bays formed by steel stoplog supports, the stoplog supports can provide up to three (3) feet of weir height. Flow discharging through the spillway falls approximately 14.5 feet down to a riprap toe, as reported in the June 1979 Hopedale Pond Dam Phase I Inspection Report, before continuing through channels beneath the downstream factory building (which is being demolished at the time of this report).

Based on field measurements of the spillway and the reported 14.5 feet of drop to the downstream riprap toe, the dam has a maximum structural height of approximately 20.2 feet to the base of the dam. The hydraulic height of the dam is approximately 17.2 feet based on the elevation of the spillway crest with 3 feet of stoplogs to the base of the dam and approximately 14.2 feet to the spillway crest weir. The dam is currently classified as an Intermediate size, Significant Hazard structure; therefore, the dam's Spillway Design Flood is the 100-year storm per the Massachusetts Dam Safety regulations of 302 CMR 10.14. The last Phase I Inspection/Evaluation Report was completed by Lenard Engineering on July 18, 2017. Figures 1 and 2 included as Enclosure 1 to this report shows the location of the dam.

# 2 Hydraulic and Hydrologic Analysis

## 2.1 Hydrology

Tighe & Bond performed the hydrologic analysis for Hopedale Pond Dam using rainfall runoff modeling and regression analysis to evaluate the adequacy of the spillway's hydraulic capacity. Hopedale Pond Dam is classified as an Intermediate size, Significant hazard structure; therefore, the corresponding Spillway Design Flood (SDF) is the 100-year frequency storm event based on DCR ODS guidelines.

Tighe & Bond performed the rainfall runoff modeling using the HydroCAD stormwater modeling program, which is based on the United States Department of Agriculture's (USDA) Technical Release 20 program (TR 20). The model was developed using information from GIS mapping, soil characteristics, watershed characteristics, and ground cover types within the watershed. The reservoir and dam were evaluated for flow rates generated by the 2, 5, 10, 25, 50, 100-, and 500-year frequency storm events.

The 24-hour precipitation was estimated for this location using the National Oceanic and Atmospheric Administration's (NOAA) Atlas 14 Volume 10, considered the most up to date for the region. Table 1 provides the precipitation amounts used for the storm events analyzed. A 24-hour synthetic storm developed from the NOAA Atlas 14 Intensity Duration Frequency (IDF) for each storm event was used to provide a rainfall distribution.

**TABLE 1**
24-hour Precipitation Values Used in Hydrologic Analysis

| Storm Return Frequency | Precipitation Values (inches) |
|---|---|
| 2-year | 3.39 |
| 5-year | 4.39 |
| 10-year | 5.23 |
| 25-year | 6.38 |
| 50-year | 7.23 |
| 100-year | 8.16 |
| 500-year | 11.1 |

Principal hydrology input values for the modeling program include: rainfall depth, the total contributing watershed area, land use, hydrologic soil types based on USDA Natural Resources Conservation Service soil surveys, and time of concentration. The time of concentration was determined using the empirical Soil Conservation Service (SCS) lag formula method, which is a function of the length of the watershed, the average slope of the watershed, and the SCS curve number (CN). The time of concentration is related to the lag time by a factor of 1.67.

Given the location of Hopedale Pond Dam being downstream of several other dams, the watershed was divided into six sub-basins in the analysis to accurately model potential inflows to Hopedale Pond Dam. The sub-basins were organized based on the locations of the upstream impoundments. Table 2 provides a summary of the HydroCAD model input values.

**TABLE 2**
Sub-basin Characteristics Used in HydroCAD Model

| Sub-basin ID | Downstream Design Point | Drainage Area (acres) | Curve Number | Time of Concentration (minutes) |
|---|---|---|---|---|
| 1 | Hopedale Pond Dam (MA00624) | 2090 | 71 | 163 |
| 2 | Hopedale Pond | 48 | 98 | 5 |
| 3 | Mill Pond Dam (MA00625) | 672 | 73 | 108 |
| 4 | Fiske Mill Pond Dam (MA00626) | 1748 | 72 | 189 |
| 5 | Lake Maspenock Dam (MA00627) | 1567 | 67 | 100 |
| 6 | Lake Maspenock | 252 | 98 | 89 |

The Hopedale Pond Dam watershed has a total drainage area of approximately 10 square miles and consists of mostly forested land (60%), impervious areas (10%), and developed open space (10%).

Approximately 40% of the soils within the watershed have a hydrologic soil group rating of C and 29% of the soils have a hydrologic soil group rating of D, which have low infiltration rates. Of the remaining soils, approximately 21% have a hydrologic soil group rating of B and 9% have a group rating of A, which have moderate to high infiltration rates. Figure 2 shows the watershed and delineated sub basins.

The selected peak flood events were also calculated using regression analyses to validate the results of the HydroCAD model. Regression peak flow were calculated using the Zarriello 2017[1] approach available in the USGS Streamstats program[2]. The regression analysis results were used as the basis for comparison with the computed design peak flood events from the HydroCAD model.

## 2.2 Hydraulics

The hydraulics analysis for Hopedale Pond Dam was performed using the previously described hydrologic model in HydroCAD. A digital elevation model (DEM) of the watershed was developed from MassGIS LIDAR data. The geometry of the dams located upstream of Hopedale Pond Dam was determined from field measurements and historical inspection reports.

Table 3 and Table 4 provides a summary of the hydraulic model input for the Hopedale Pond Dam, and upstream dams within the watershed, respectively. The Hopedale Dam hydraulic information, including the normal pool elevation relative to the dam crest, was determined from a combination of field reconnaissance and the Hopedale Pond Dam Spillway Repairs drawings, prepared by Pare Corporation, dated September 2010.

Storage volumes were calculated for the impoundments above each respective normal pool using the DEM and the GIS elevation volume curve tool. The storage below the normal pool

[1] Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p.
[2] U.S. Geological Survey, 2016, The StreamStats program, online at http://streamstats.usgs.gov, accessed April 11, 2021.

was calculated using information provided in their respective previous Phase I reports or calculated using the conic method.

**TABLE 3**
Hydraulic Information used for HydroCAD Input for Hopedale Pond Dam

| Structure | Elevation (ft, NAVD88) | Weir Length (feet) |
|---|---|---|
| Dam Crest (Freedom Street) | 275.5 | 265 |
| Dam Crest Low Chord (Top of spillway opening) | 273.95** | - |
| Spillway Crest (No stoplogs) | 269.8 | 37.4* |
| Spillway Crest (With Stoplogs) | 272.5 | 37.4* |

*The spillway consists of 5 openings separated by concrete piers; the combined opening width is 37.4 feet. Estimated based on design drawings due to unsafe access.
**Based on field reconnaissance.

**TABLE 4**
Hydraulic Information used for HydroCAD Input for Upstream Dams

| Structure | Elevation (ft, NAVD88) | Weir Length (feet) |
|---|---|---|
| | Lake Maspenock Dam (MA00627) | |
| Dam Crest | 349.3 | 765 |
| Spillway Crest | 347.3 | 35 |
| | Fiske Mill Pond Dam (MA00626) | |
| Dam Crest | 299.8 | 153 |
| Spillway Crest | 296.5 | 47 |
| | Mill Pond Dam (MA00625) | |
| Dam Crest | 285 | 145 |
| Spillway Crest | 282.1 | 9.5 |

Note that the existing stoplogs are mounted below a water main supported by the bridge which severely restricts the spillway discharge capacity. This restriction was modeled as a vertical orifice with a vertical opening of 9 inches, which was estimated from design drawings since the area is not safe to access.

# 3 Results

Table 5 and Figure 3 show the peak flow results from the HydroCAD model as well as the predicted peak flows and prediction intervals from the regression analysis.

**TABLE 5**
Computed flow rates at Freedom Street Dam

| Storm Event | HydroCAD Inflow (cfs) | Regression Analysis (cfs)* | | |
|---|---|---|---|---|
| | | Lower 90% Confidence Interval | Prediction | Upper 90% Confidence Interval |
| 2-year | 427.6 | 120 | 233 | 454 |
| 5-year | 759.4 | 194 | 283 | 756 |
| 10-year | 1057.6 | 248 | 501 | 1,010 |
| 25-year | 1474.2 | 322 | 672 | 1,400 |
| 50-year | 1794.3 | 378 | 814 | 1,760 |
| 100-year | 2140.8 | 433 | 963 | 2,140 |
| 500-year | 3359.0 | 568 | 1,360 | 3,260 |

* Regression analysis completed using "Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156" (Zarriello 2017)

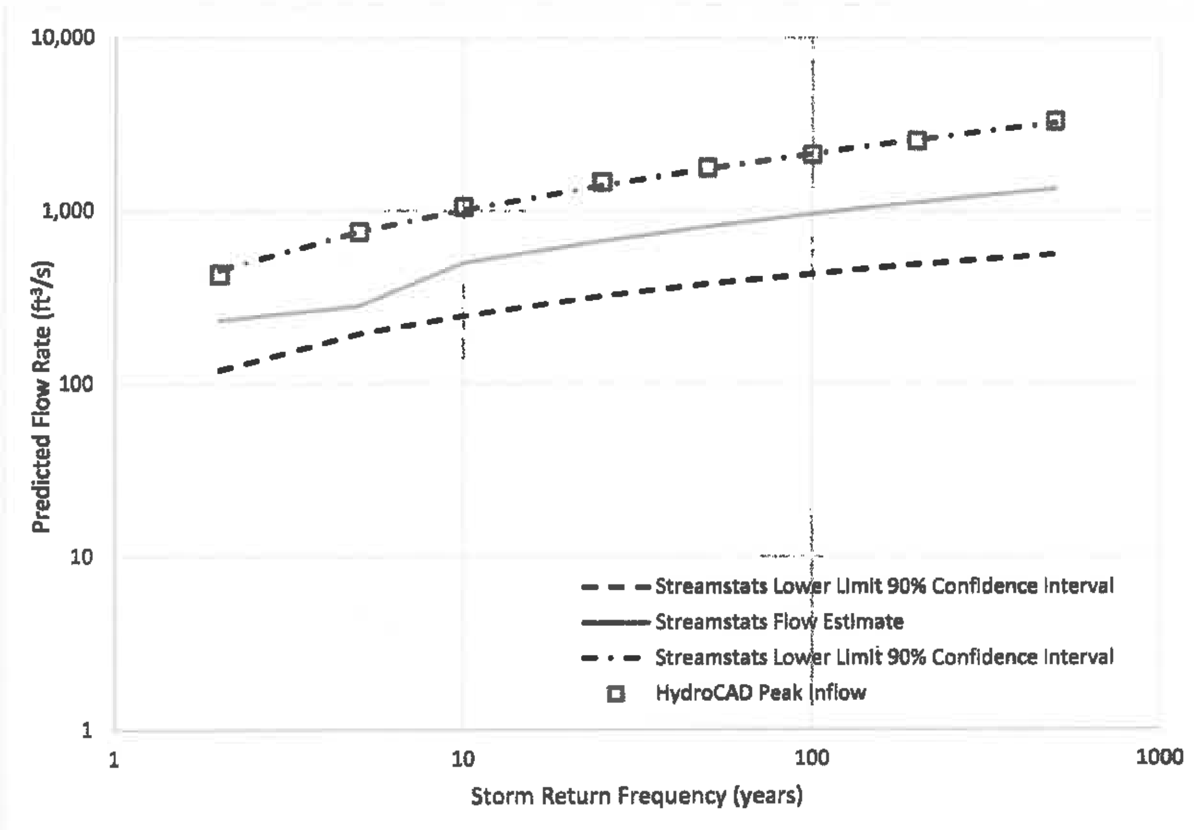



**FIGURE 3**
Comparison of the HydroCAD results to the predictions from the regression analysis

In general, the peak flows estimated using HydroCAD are at the upper limit of the regression analysis values, with predicted flow rates slightly above the 90 percent confidence intervals. The higher values estimated from HydroCAD are likely due to the urban areas, predominance of Type C soils, and large surface area of upstream water bodies (i.e. Lake Maspenock and Hopedale Pond) of the watershed. Based on this comparison, the HydroCAD model results provide a reasonable estimate of flow rates generated by the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency storm events.

The HydroCAD model results at Hopedale Pond Dam are presented in Table 6. HydroCAD model output is provided as Enclosure 2 to this report. The HydroCAD results and modeled stage-discharge relationship for existing conditions, assuming that the dam's stoplogs are in place at Hopedale Pond Dam are presented in Figure 4.

**TABLE 6**
Hydrologic/Hydraulic Analysis Results for Existing Conditions at Hopedale Pond Dam

| Storm Event | Peak Flow into Impoundment (cfs) | Peak Discharge (cfs) | Peak Water Surface Elevation (NAVD88) | Freeboard to Dam Crest (Freedom Street) |
|---|---|---|---|---|
| 2-year | 428 | 97 | 273.8 | 1.7 |
| 5-year | 759 | 141 | 274.3 | 1.2 |
| 10-year | 1058 | 168 | 274.8 | 0.7 |
| 25-year | 1474 | 223 | 275.5 | 0.0 |
| 50-year | 1794 | 430 | 275.8 | -0.3 |
| 100-year | 2141 | 627 | 276.1 | -0.6 |
| 500-year | 3359 | 1331 | 276.8 | -1.3 |

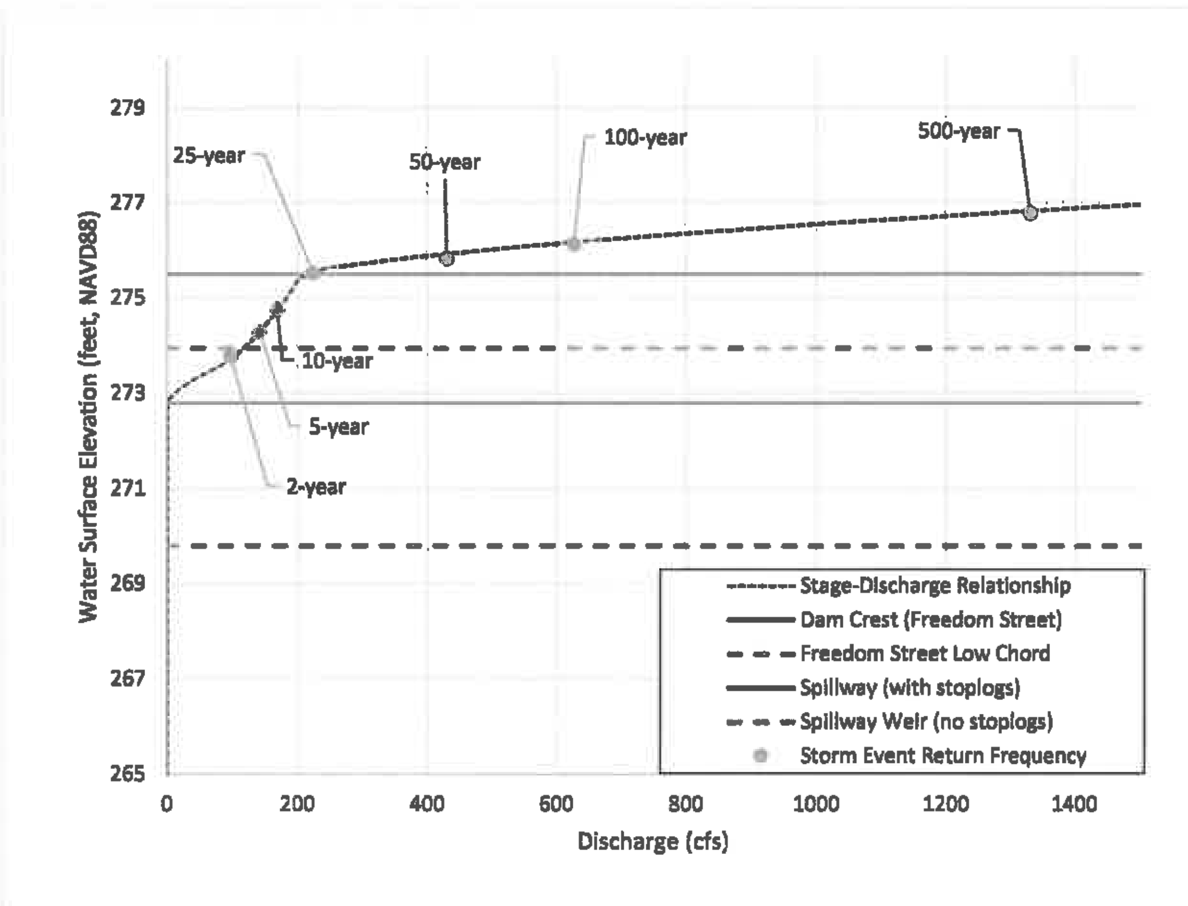



**FIGURE 4**
Elevation-Discharge Relationship for Existing Conditions at Hopedale Pond Dam

Based on the H&H analysis results, Hopedale Pond Dam has the capacity to pass approximately 220 cfs without overtopping the dam crest. The spillway can pass the 2-, 5-, 10-, and 25-year frequency flood event without overtopping the dam crest; however, the spillway can only pass the 2-year storm event with approximately 0.2 feet of freeboard to the low-chord (i.e., the roof of culvert) at Freedom Street. The 100-year and 500-year flood event is expected to overtop the dam crest by approximately 0.6 feet and 1.3 feet, respectively. It is important to note that these results do not consider the potential downstream constrictions that may limit discharge capacity; the objective of this study is to compare stoplog alternatives rather than determine the dam's absolute discharge capacity.

# 4 Proposed Improvements

The stoplogs are currently inaccessible and need to be relocated, and evaluation of the impact of relocation alternatives on the dam's discharge capacity is important. Three alternatives were evaluated to provide access to the stoplogs are:

- Alternative 1: Relocate the stoplogs upstream of the bridge piers by several feet
- Alternative 2: Relocate the stoplogs to the upstream sides of the bridge piers as proposed by BETA, Inc.
- Alternative 3: Relocate the stoplogs to the downstream end of the existing spillway, beyond the edge of the sidewalk

The HydroCAD model results at Hopedale Pond Dam for Alterative 1 (relocating the stop logs several feet upstream) during each of the modeled storm events are presented in Table 7. Table 8 and 9 provides the HydroCAD results for relocating the stoplogs to the upstream face of the bridge piers (Alternative 2) and relocating the stoplogs to the downstream edge of the spillway for comparison, respectively. Figures 5, 6, and 7 show the HydroCAD results and modeled stage-discharge relationship for the proposed conditions at Hopedale Pond Dam for Alternative 1, Alternative 2, and Alternative 3, respectively.

**TABLE 7**
**Hydrologic/Hydraulic Analysis Results for Proposed Conditions Alternative 1 at Hopedale Pond Dam (relocating stoplogs upstream of bridge piers)**

| Storm Event | Peak Flow into Impoundment (cfs) | Peak Discharge (cfs) | Peak Water Surface Elevation (NAVD88) | Freeboard to Dam Crest (Freedom Street) |
|---|---|---|---|---|
| 2-year | 428 | 146 | 273.6 | 1.9 |
| 5-year | 759 | 231 | 273.9 | 1.6 |
| 10-year | 1058 | 350 | 274.3 | 1.2 |
| 25-year | 1474 | 533 | 274.7 | 0.8 |
| 50-year | 1794 | 673 | 275.1 | 0.4 |
| 100-year | 2141 | 838 | 275.5 | 0.1 |
| 500-year | 3359 | 1581 | 276.1 | -0.6 |

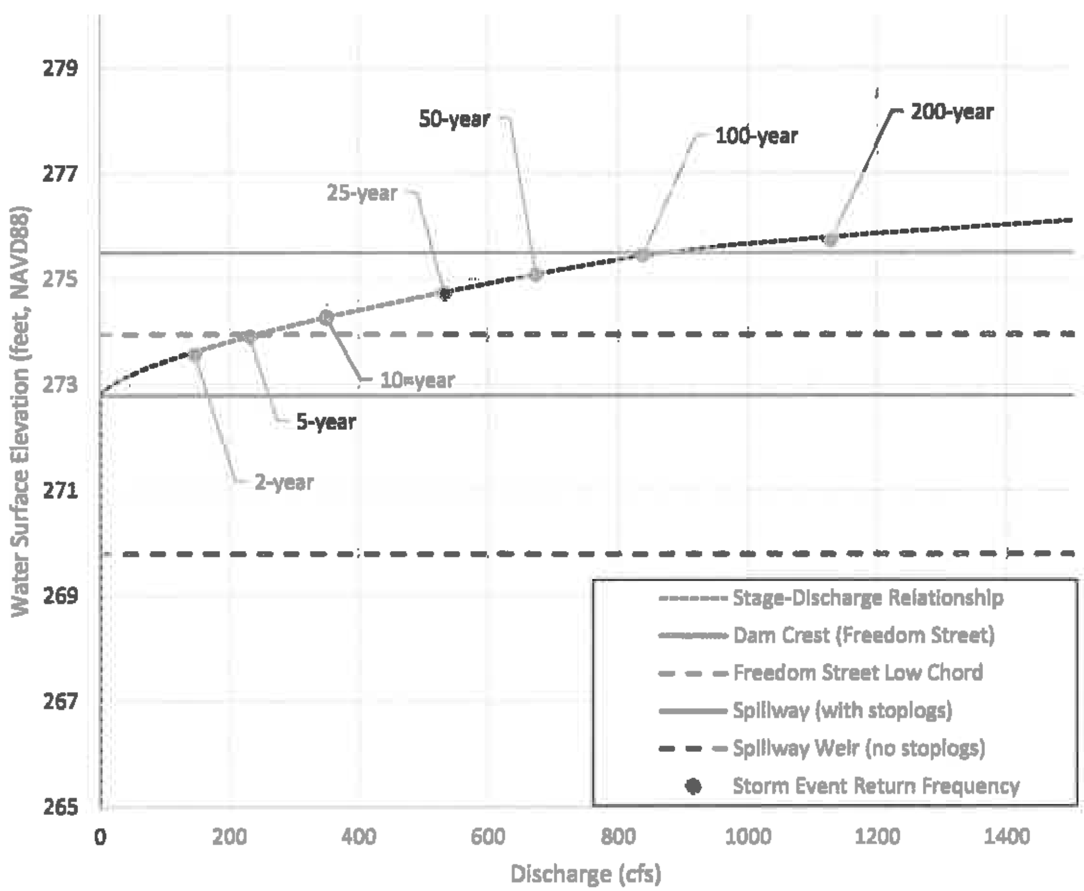



**FIGURE 5**
**Elevation-Discharge Relationship for Alternative 1 at Hopedale Pond Dam (stoplogs located approximately 8 feet upstream of upstream face of dam)**

**TABLE 8**
**Hydrologic/Hydraulic Analysis Results for Alternative 2 at Hopedale Pond Dam (relocate stoplogs to upstream bridge pier faces)**

| Storm Event | Peak Flow Into Impoundment (cfs) | Peak Discharge (cfs) | Peak Water Surface Elevation (NAVD88) | Freeboard to Dam Crest (Freedom Street) |
|---|---|---|---|---|
| 2-year | 428 | 112 | 273.7 | 1.8 |
| 5-year | 759 | 183 | 274.1 | 1.4 |
| 10-year | 1058 | 260 | 274.5 | 1.0 |
| 25-year | 1474 | 380 | 275.2 | 0.4 |
| 50-year | 1794 | 475 | 275.6 | -0.1 |
| 100-year | 2141 | 690 | 275.9 | -0.4 |
| 500-year | 3359 | 1373 | 276.6 | -1.1 |

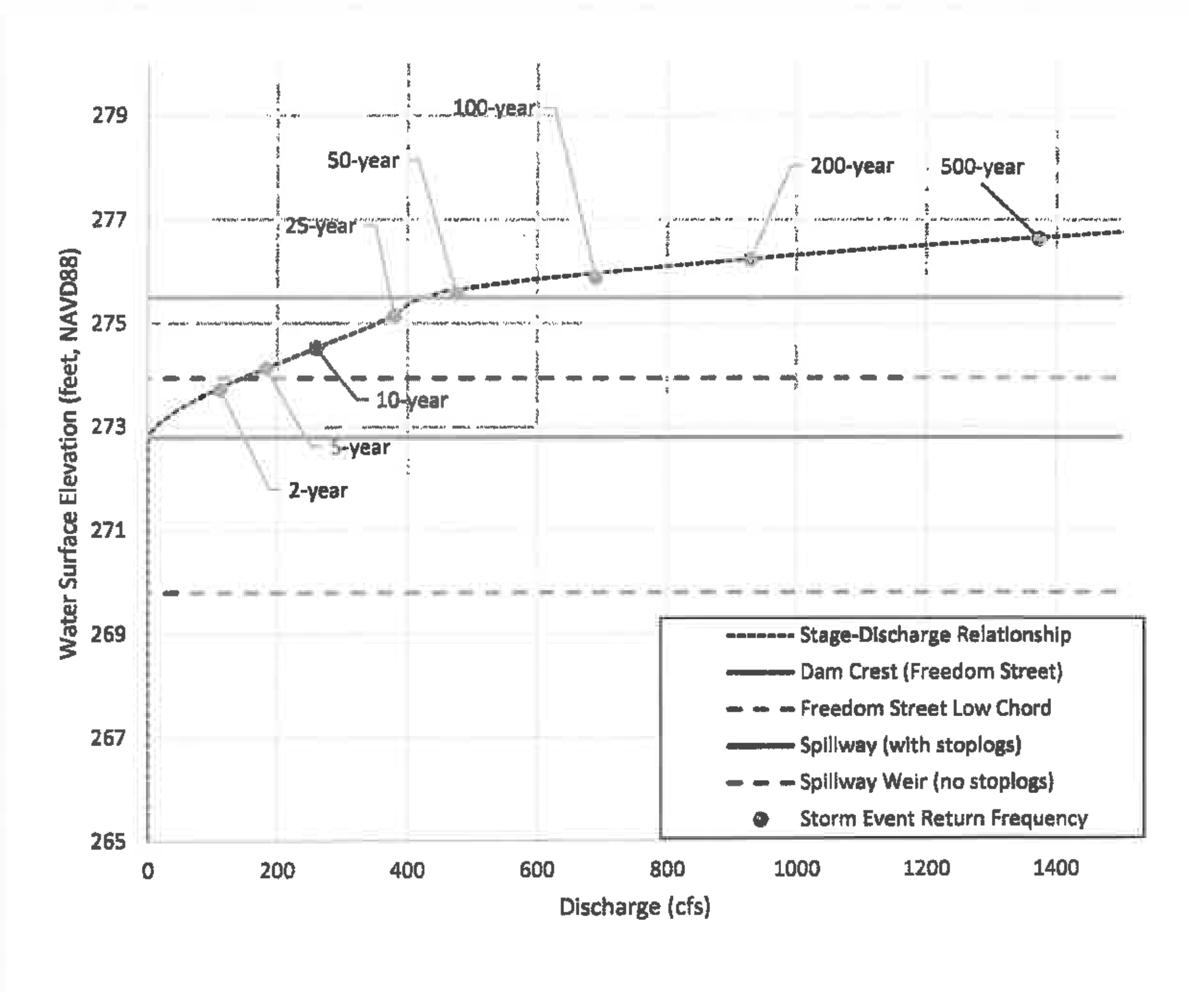



**FIGURE 6**
**Elevation-Discharge Relationship for Alternative 2 at Hopedale Pond Dam (stoplogs abutting upstream face of dam)**

**TABLE 9**
**Hydrologic/Hydraulic Analysis Results for Alternative 3 at Hopedale Pond Dam (relocate stoplogs to downstream edge of spillway, beyond edge of sidewalk)**

| Storm Event | Peak Flow Into Impoundment (cfs) | Peak Discharge (cfs) | Peak Water Surface Elevation (NAVD88) | Freeboard to Dam Crest (Freedom Street) |
|---|---|---|---|---|
| 2-year | 428 | 136 | 273.6 | 1.9 |
| 5-year | 759 | 216 | 274.0 | 1.5 |
| 10-year | 1058 | 320 | 274.4 | 1.1 |
| 25-year | 1474 | 449 | 274.9 | 0.6 |
| 50-year | 1794 | 553 | 275.4 | 0.1 |
| 100-year | 2141 | 744 | 275.7 | -0.2 |
| 500-year | 3359 | 1422 | 276.5 | -1.0 |

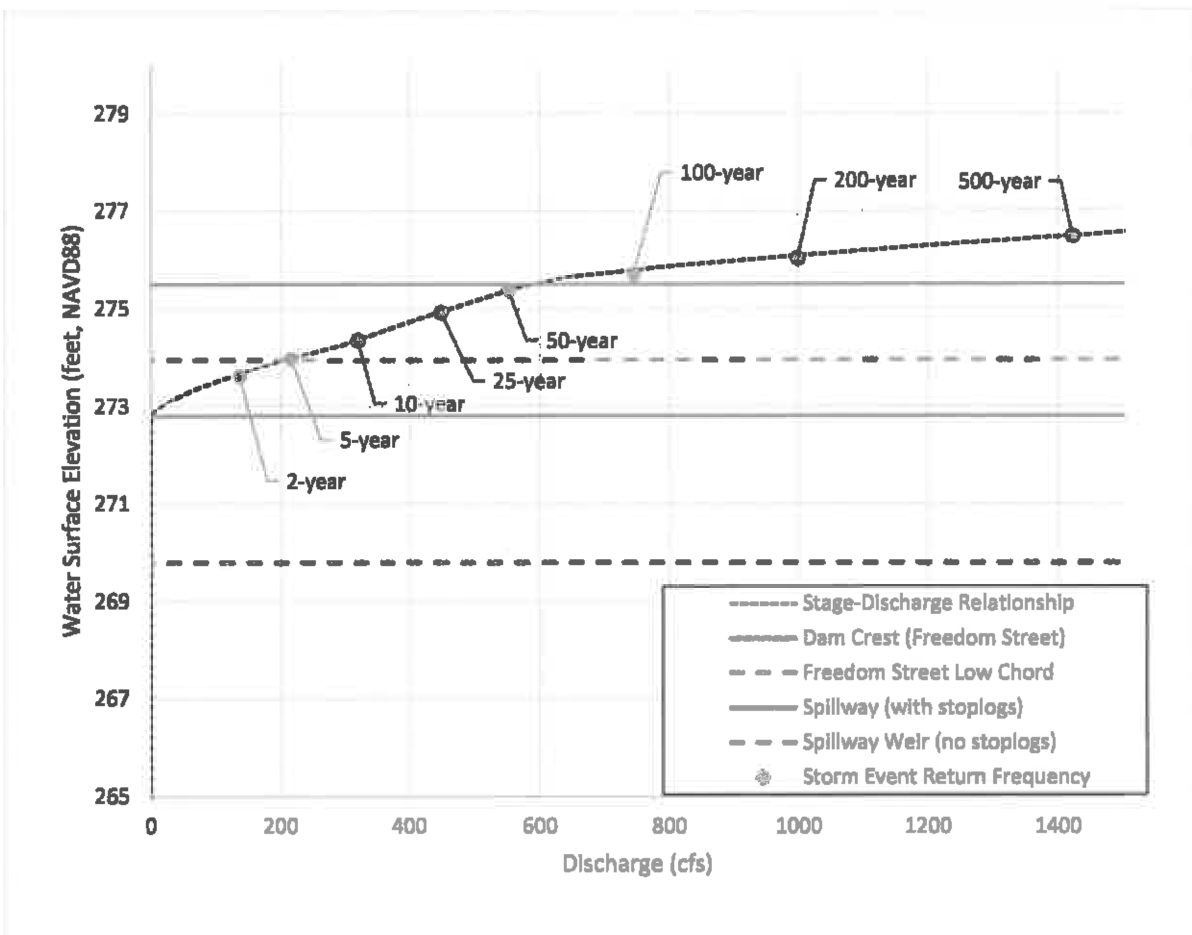



**FIGURE 7**
**Elevation-Discharge Relationship for Alternative 3 at Hopedale Pond Dam (stoplogs relocated to downstream of the existing sidewalk)**

Based on the H&H analysis results, Alternative 1 (moving stoplogs upstream of the bridge) at Hopedale Pond Dam would have the capacity to pass approximately 890 cfs without overtopping Freedom Street. The spillway could pass the 100 year frequency flood event with approximately 0.1 feet of freeboard (note that at least 1 foot of freeboard is preferred following general dam safety design practice). With the proposed improvements, the 100-year flood event would no longer overtop the dam. Alternatives 2 and 3 could not pass the 100-year flood event. However, Alternatives 2 and 3 still represent an improvement compared to existing conditions.

The hydraulic capacity of Alternative 1 could be further increased if stoplogs are removed prior to the start of the design storm event. For example, if Alternative 1 were implemented, one foot of freeboard could be achieved during the 100-year frequency storm event if 15 feet of stoplogs were removed (to an elevation of 269.8 feet NAVD88) 24 hours prior to the start of the design storm event assuming a 50 percent duration baseflow of 9.971 cfs. Table 10 shows the HydroCAD results for Alternative 1 with 15 feet of stoplogs removed 24 hours prior to the start of the design storm events (Alternative 1A). This is one of many examples of stoplog approaches that could increase freeboard prior to a storm event.

**TABLE 6**
Hydrologic/Hydraulic Analysis Results for Alternative 1A at Hopedale Pond Dam (relocating stoplogs 8 feet upstream of the upstream dam face and remove 15 feet of stoplogs 24 hours prior to storm event)*

| Storm Event | Peak Flow Into Impoundment (cfs) | Peak Discharge (cfs) | Peak Water Surface Elevation (NAVD88) | Freeboard to Dam Crest (Freedom Street) | Freeboard to Low Chord (Freedom Street) |
|---|---|---|---|---|---|
| 2-year | 428 | 201 | 271.7 | 3.8 | 2.3 |
| 5-year | 759 | 265 | 272.2 | 3.3 | 1.8 |
| 10-year | 1058 | 344 | 272.8 | 2.7 | 1.1 |
| 25-year | 1474 | 555 | 273.6 | 1.9 | 0.4 |
| 50-year | 1794 | 709 | 274.0 | 1.5 | -0.1 |
| 100-year | 2141 | 866 | 274.5 | 1.0 | -0.5 |
| 500-year | 3359 | 1375 | 275.7 | -0.2 | -1.8 |

*Modeled in HydroCAD with a 50-percent duration baseflow of 9.67 cfs based on Streamstats[1].

Enclosures:

1. Full Page Figures
2. HydroCAD Summary Output

\\tighebond.com\data\Data\Projects\H\H5025 Hopedale\002 - Freedom Street Dam\Report\H&H Report\FreedomStreet_H&H_Tech_Memo.docx

# Attachment A
# Figures


**Legend**

★ Hopedale Pond Dam

Town Boundary

Tighe&Bond
Engineers | Environmental Specialists

Based on MassGIS Color Orthophotography (2019)

1:12,000 1 in = 1,000 ft

0 500 1,000

Feet

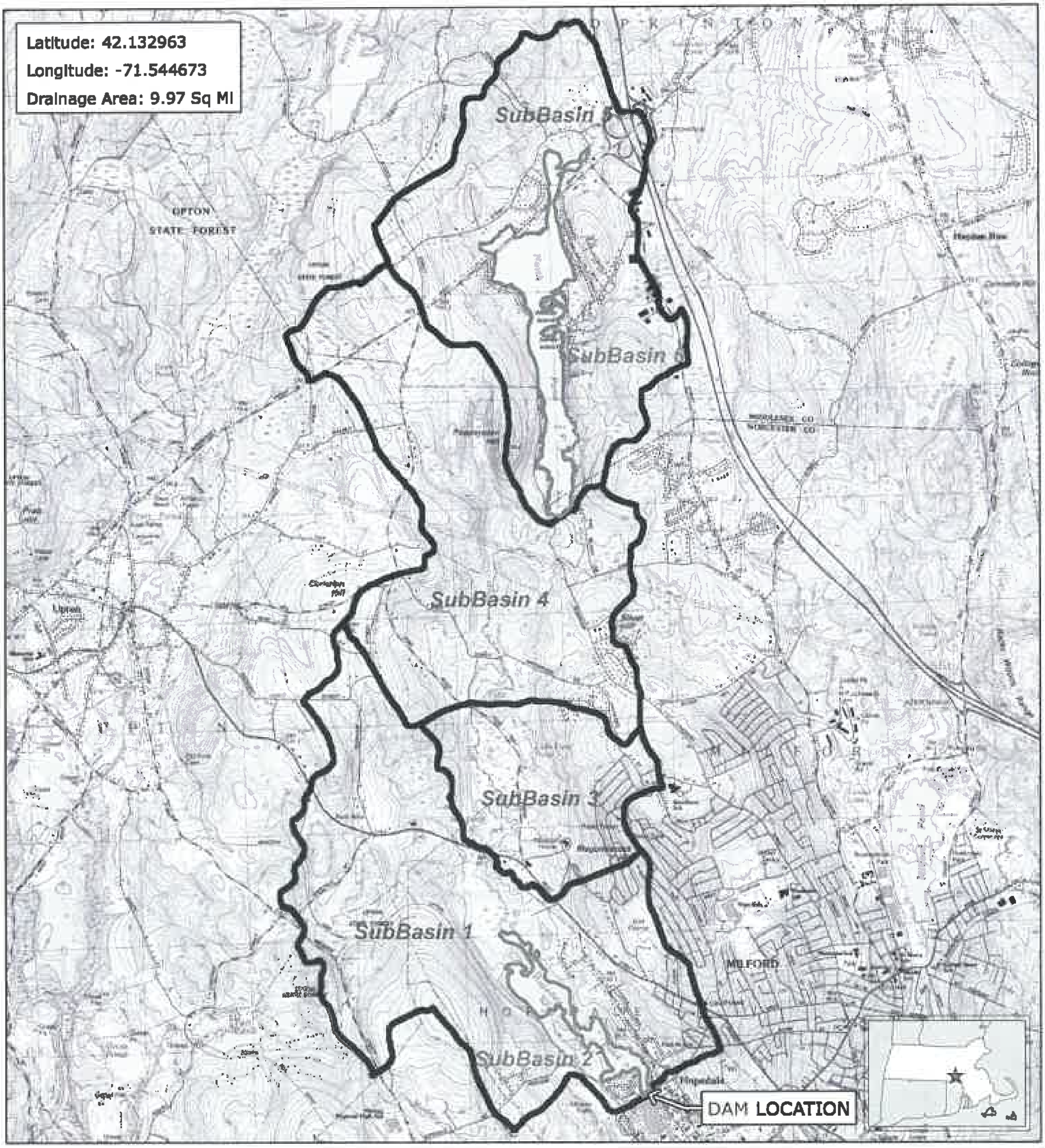
N

## FIGURE 1
## ORTHOPHOTOGRAPH

Hopedale Pond Dam
Hopedale, Massachusetts
MA00624

May 2021

J:\...\5025 Hopedale\002 - Freedom Street Dam Re...\&H Report\Attachments\...\Dam_Aerial.mxd (Exported By: CYWu 8/24/2021 3:29:41 PM) H-5025




## Legend

Pond_Areas

Drainage Area

Tighe&Bond
Engineers | Environmental Specialists

Based on USGS Topographic Map for Milford, MA Revised 1982. Contour Equals 3-Meters. Drainage Area Calculated in USGS StreamStats V4.3.0: MA

1:48,000 1 in = 4,000 ft

0 2,000 4,000
Feet

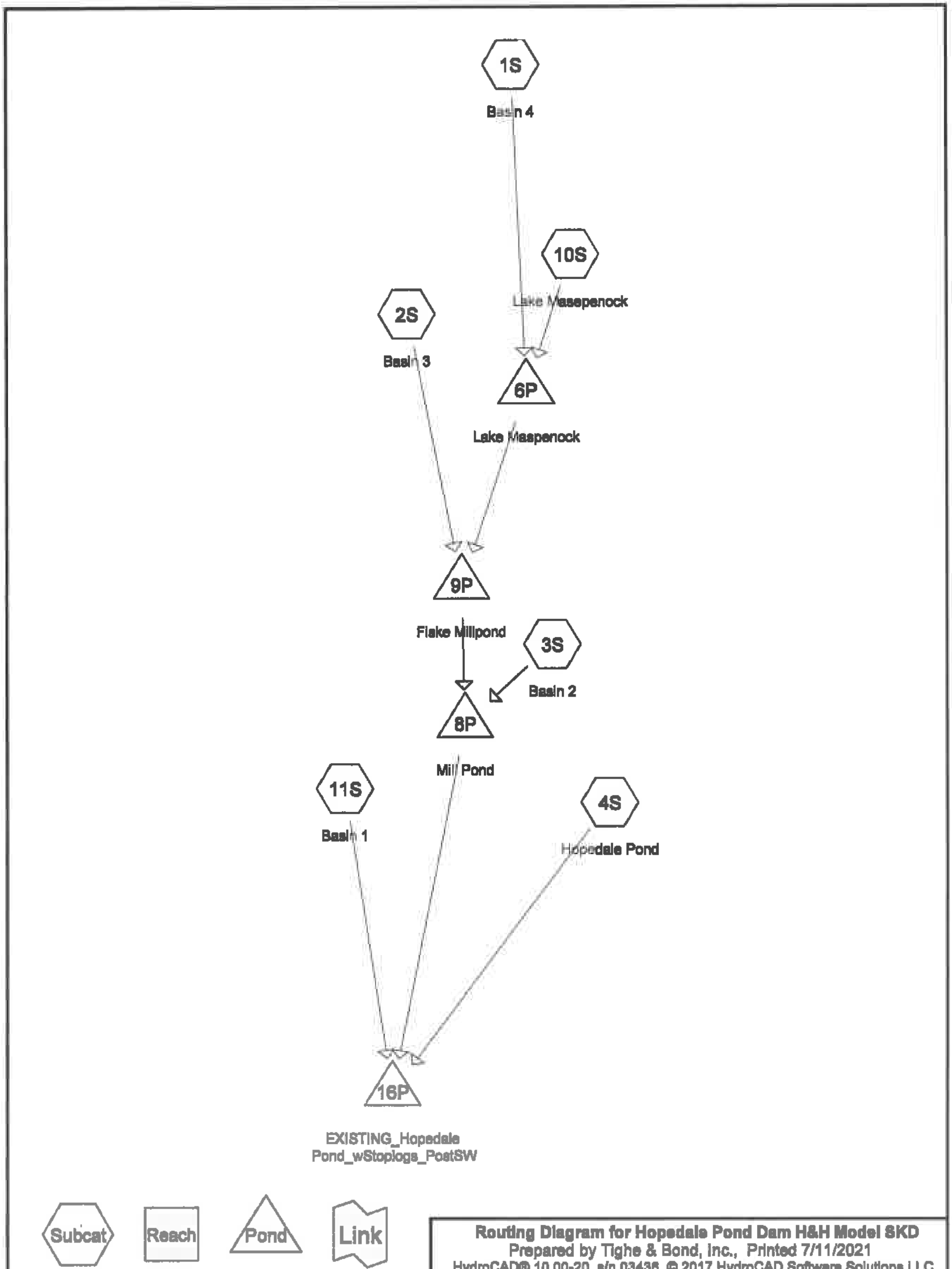
N

**FIGURE 2**
**DRAINAGE AREA MAP**

Hopedale Pond Dam
Hopedale, Massachusetts
MA00624

November 2021

# Attachment B
# HydroCAD Summary Output



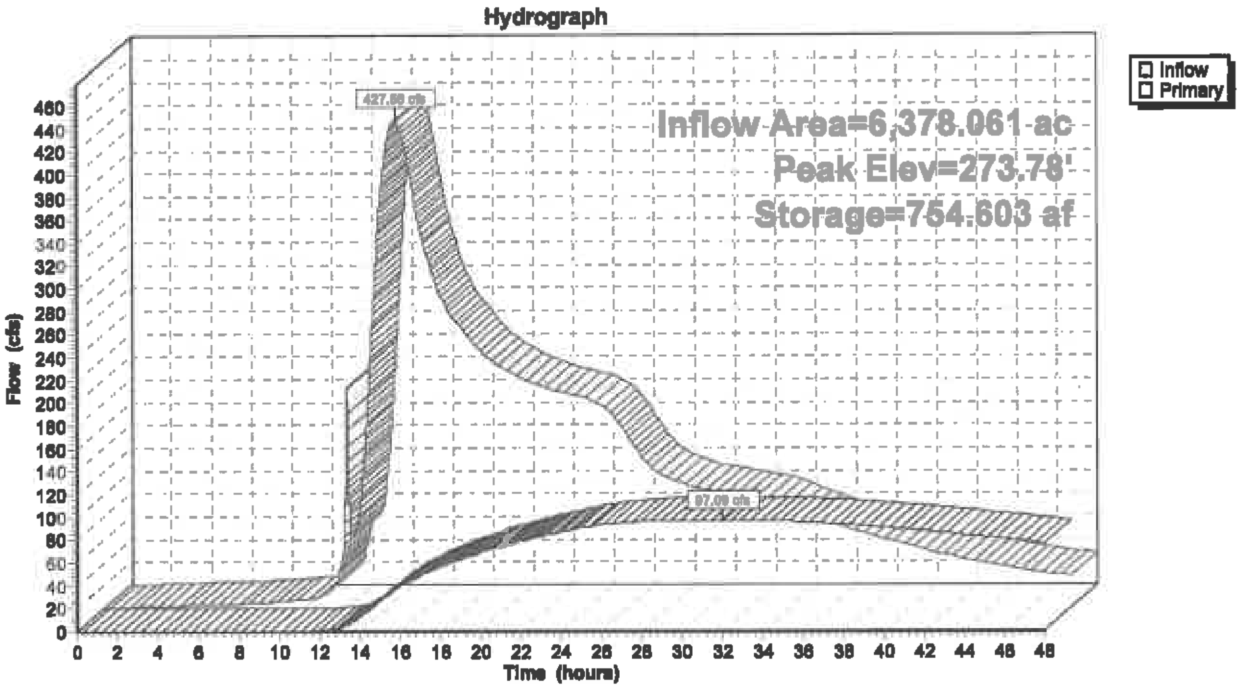

**Routing Diagram for Hopedale Pond Dam H&H Model SKD**
Prepared by Tighe & Bond, Inc., Printed 7/11/2021
HydroCAD® 10.00-20 s/n 03436 © 2017 HydroCAD Software Solutions LLC

| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" W x 9.0" H Vert. oriface 1** C= 0.600 |
| #3 | Primary | 272.80' | **86.0" W x 9.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 9.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 9.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 9.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=103.71 cfs @ 32.01 hrs HW=273.78' (Free Discharge)
- **1=road** ( Controls 0.00 cfs)
- **2=oriface 1** (Orifice Controls 27.25 cfs @ 3.70 fps)
  - **7=Culvert 1** (Passes 27.25 cfs of 151.59 cfs potential flow)
- **3=oriface 2** (Orifice Controls 19.86 cfs @ 3.70 fps)
  - **8=Culvert 2** (Passes 19.86 cfs of 110.48 cfs potential flow)
- **4=oriface 3** (Orifice Controls 23.10 cfs @ 3.70 fps)
  - **9=Culvert 3** (Passes 23.10 cfs of 128.46 cfs potential flow)
- **5=oriface 4** (Orifice Controls 22.87 cfs @ 3.70 fps)
  - **10=Culvert 4** (Passes 22.87 cfs of 127.18 cfs potential flow)
- **6=oriface 5** (Orifice Controls 10.62 cfs @ 3.70 fps)
  - **11=Culvert 5** (Passes 10.62 cfs of 59.09 cfs potential flow)

## Pond 16P: EXISTING_Hopedale Pond_wStoplogs_PostSW

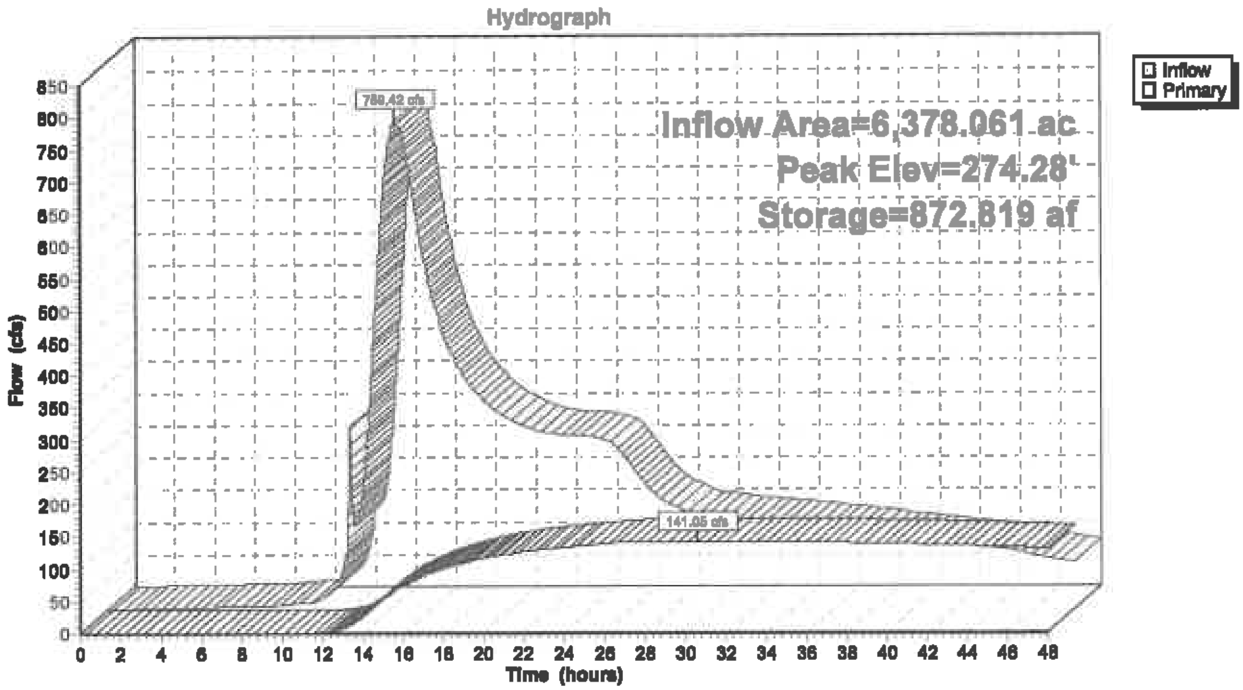


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" W x 9.0" H Vert. oriface 1** C= 0.600 |
| #3 | Primary | 272.80' | **86.0" W x 9.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 9.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 9.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 9.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=141.17 cfs @ 30.59 hrs HW=274.28' (Free Discharge)
- **1=road** ( Controls 0.00 cfs)
- **2=oriface 1** (Orifice Controls 37.10 cfs @ 5.03 fps)
  - **7=Culvert 1** (Passes 37.10 cfs of 197.13 cfs potential flow)
- **3=oriface 2** (Orifice Controls 27.04 cfs @ 5.03 fps)
  - **8=Culvert 2** (Passes 27.04 cfs of 143.67 cfs potential flow)
- **4=oriface 3** (Orifice Controls 31.44 cfs @ 5.03 fps)
  - **9=Culvert 3** (Passes 31.44 cfs of 167.06 cfs potential flow)
- **5=oriface 4** (Orifice Controls 31.13 cfs @ 5.03 fps)
  - **10=Culvert 4** (Passes 31.13 cfs of 165.39 cfs potential flow)
- **6=oriface 5** (Orifice Controls 14.46 cfs @ 5.03 fps)
  - **11=Culvert 5** (Passes 14.46 cfs of 76.85 cfs potential flow)

## Pond 16P: EXISTING_Hopedale Pond_wStoplogs_PostSW

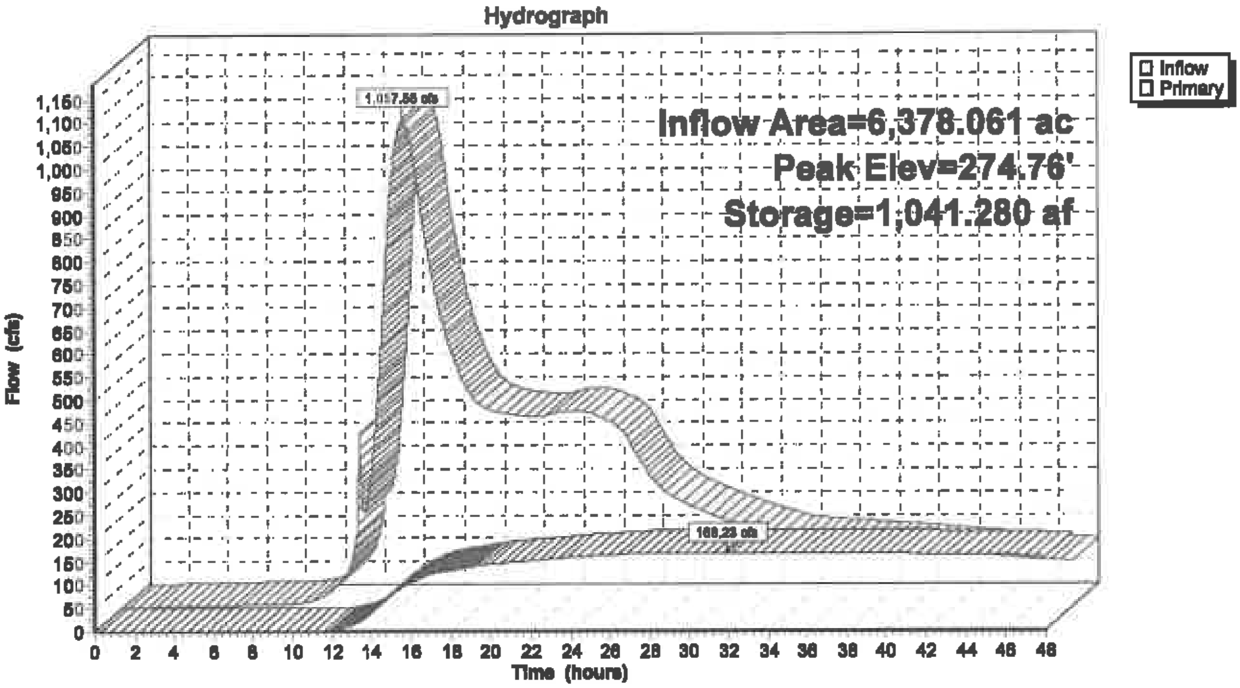


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" W x 9.0" H Vert. oriface 1** C= 0.600 |
| #3 | Primary | 272.80' | **86.0" W x 9.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 9.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 9.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 9.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=169.87 cfs @ 31.92 hrs HW=274.76' (Free Discharge)
—**1=road** ( Controls 0.00 cfs)
—**2=oriface 1** (Orifice Controls 44.64 cfs @ 6.05 fps)
  —**7=Culvert 1** (Passes 44.64 cfs of 231.78 cfs potential flow)
—**3=oriface 2** (Orifice Controls 32.54 cfs @ 6.05 fps)
  —**8=Culvert 2** (Passes 32.54 cfs of 168.92 cfs potential flow)
—**4=oriface 3** (Orifice Controls 37.83 cfs @ 6.05 fps)
  —**9=Culvert 3** (Passes 37.83 cfs of 196.42 cfs potential flow)
—**5=oriface 4** (Orifice Controls 37.46 cfs @ 6.05 fps)
  —**10=Culvert 4** (Passes 37.46 cfs of 194.46 cfs potential flow)
—**6=oriface 5** (Orifice Controls 17.40 cfs @ 6.05 fps)
  —**11=Culvert 5** (Passes 17.40 cfs of 90.35 cfs potential flow)

## Pond 16P: EXISTING_Hopedale Pond_wStoplogs_PostSW

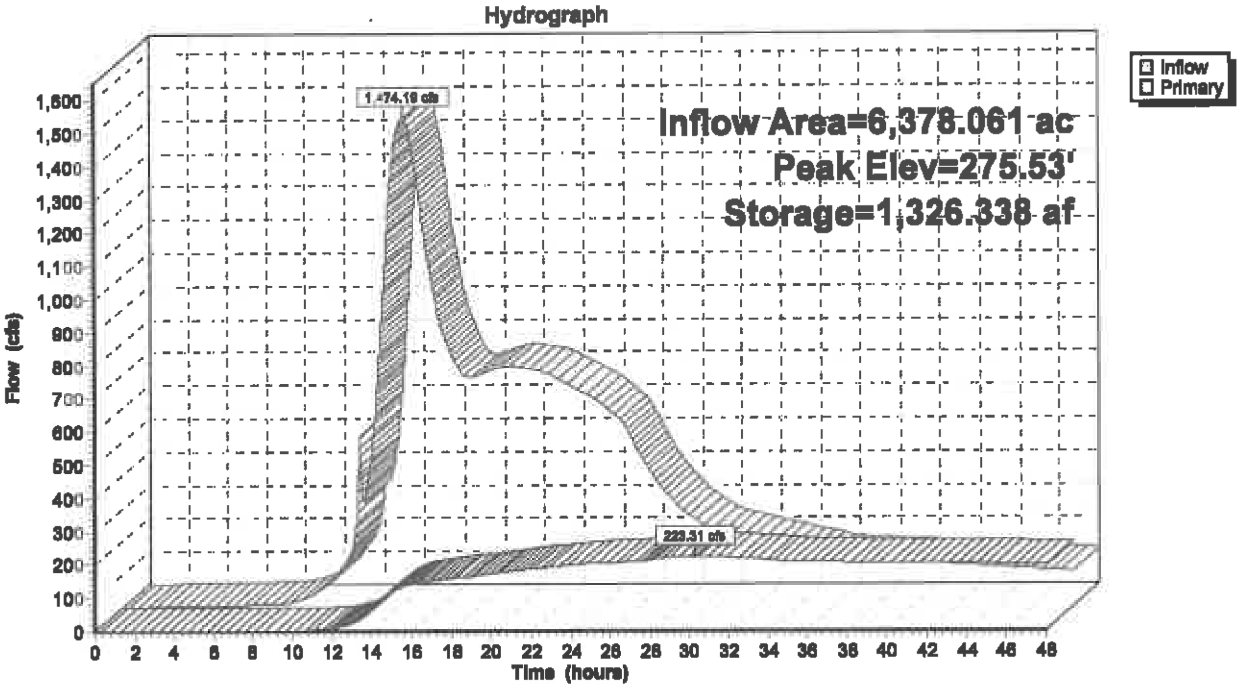


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" W x 9.0" H Vert. oriface 1** C= 0.600 |
| #3 | Primary | 272.80' | **86.0" W x 9.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 9.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 9.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 9.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=210.00 cfs @ 30.27 hrs HW=275.53' (Free Discharge)
—**1=road** (Weir Controls 3.03 cfs @ 0.43 fps)
—**2=oriface 1** (Orifice Controls 54.39 cfs @ 7.38 fps)
  └**7=Culvert 1** (Passes 54.39 cfs of 277.19 cfs potential flow)
—**3=oriface 2** (Orifice Controls 39.64 cfs @ 7.38 fps)
  └**8=Culvert 2** (Passes 39.64 cfs of 202.02 cfs potential flow)
—**4=oriface 3** (Orifice Controls 46.10 cfs @ 7.38 fps)
  └**9=Culvert 3** (Passes 46.10 cfs of 234.91 cfs potential flow)
—**5=oriface 4** (Orifice Controls 45.64 cfs @ 7.38 fps)
  └**10=Culvert 4** (Passes 45.64 cfs of 232.56 cfs potential flow)
—**6=oriface 5** (Orifice Controls 21.20 cfs @ 7.38 fps)
  └**11=Culvert 5** (Passes 21.20 cfs of 108.06 cfs potential flow)

## Pond 16P: EXISTING_Hopedale Pond_wStoplogs_PostSW

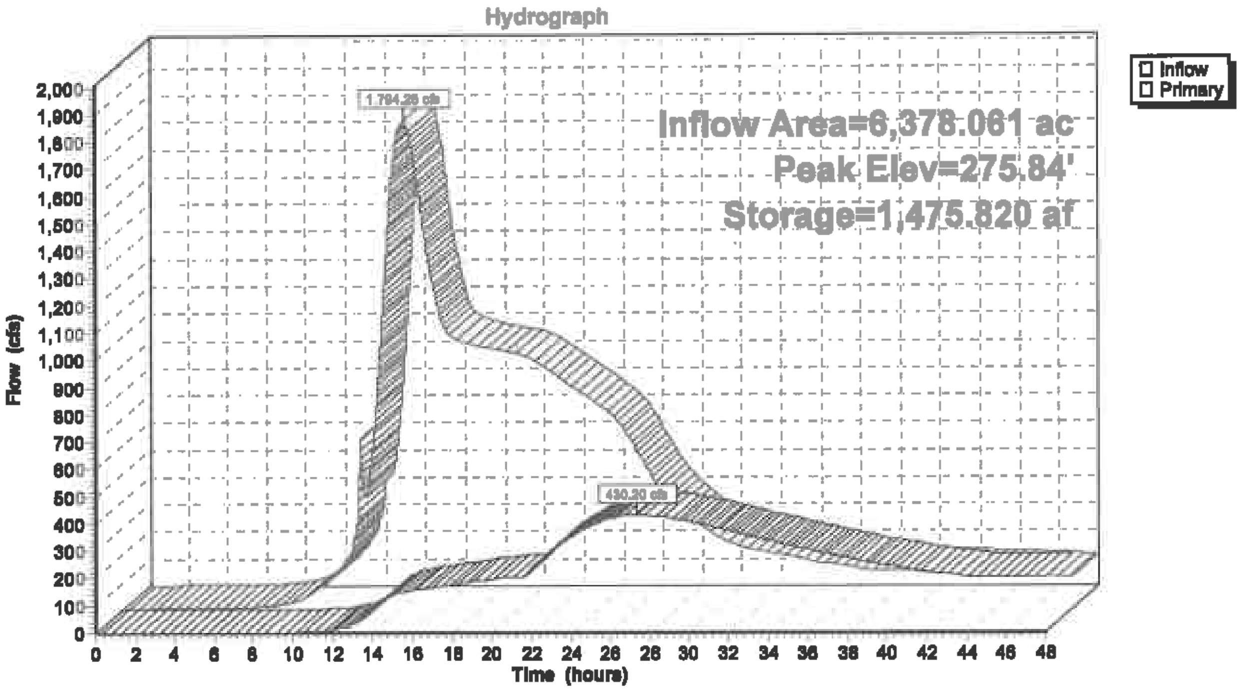


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" W x 9.0" H Vert. oriface 1** C= 0.600 |
| #3 | Primary | 272.80' | **86.0" W x 9.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 9.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 9.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 9.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=359.94 cfs @ 27.39 hrs HW=275.84' (Free Discharge)
- **1=road** (Weir Controls 139.67 cfs @ 1.56 fps)
- **2=oriface 1** (Orifice Controls 57.89 cfs @ 7.85 fps)
  - **7=Culvert 1** (Passes 57.89 cfs of 293.63 cfs potential flow)
- **3=oriface 2** (Orifice Controls 42.19 cfs @ 7.85 fps)
  - **8=Culvert 2** (Passes 42.19 cfs of 214.00 cfs potential flow)
- **4=oriface 3** (Orifice Controls 49.06 cfs @ 7.85 fps)
  - **9=Culvert 3** (Passes 49.06 cfs of 248.84 cfs potential flow)
- **5=oriface 4** (Orifice Controls 48.57 cfs @ 7.85 fps)
  - **10=Culvert 4** (Passes 48.57 cfs of 246.35 cfs potential flow)
- **6=oriface 5** (Orifice Controls 22.57 cfs @ 7.85 fps)
  - **11=Culvert 5** (Passes 22.57 cfs of 114.46 cfs potential flow)

## Pond 16P: EXISTING_Hopedale Pond_wStoplogs_PostSW

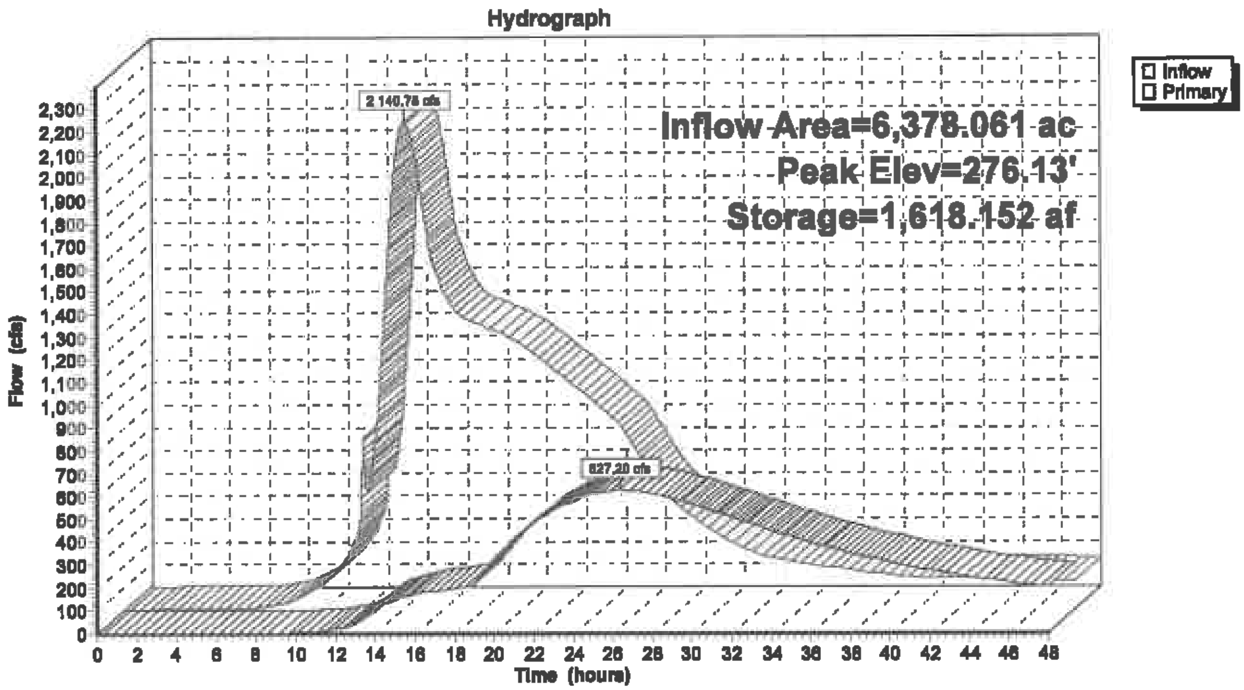


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" W x 9.0" H Vert. oriface 1** C= 0.600 |
| #3 | Primary | 272.80' | **86.0" W x 9.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 9.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 9.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 9.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=591.17 cfs @ 26.38 hrs HW=276.13' (Free Discharge)
├─**1=road** (Weir Controls 358.94 cfs @ 2.14 fps)
├─**2=oriface 1** (Orifice Controls 61.03 cfs @ 8.28 fps)
│ └─**7=Culvert 1** (Passes 61.03 cfs of 308.45 cfs potential flow)
├─**3=oriface 2** (Orifice Controls 44.48 cfs @ 8.28 fps)
│ └─**8=Culvert 2** (Passes 44.48 cfs of 224.80 cfs potential flow)
├─**4=oriface 3** (Orifice Controls 51.72 cfs @ 8.28 fps)
│ └─**9=Culvert 3** (Passes 51.72 cfs of 261.40 cfs potential flow)
├─**5=oriface 4** (Orifice Controls 51.20 cfs @ 8.28 fps)
│ └─**10=Culvert 4** (Passes 51.20 cfs of 258.78 cfs potential flow)
└─**6=oriface 5** (Orifice Controls 23.79 cfs @ 8.28 fps)
  └─**11=Culvert 5** (Passes 23.79 cfs of 120.24 cfs potential flow)

## Pond 16P: EXISTING_Hopedale Pond_wStoplogs_PostSW

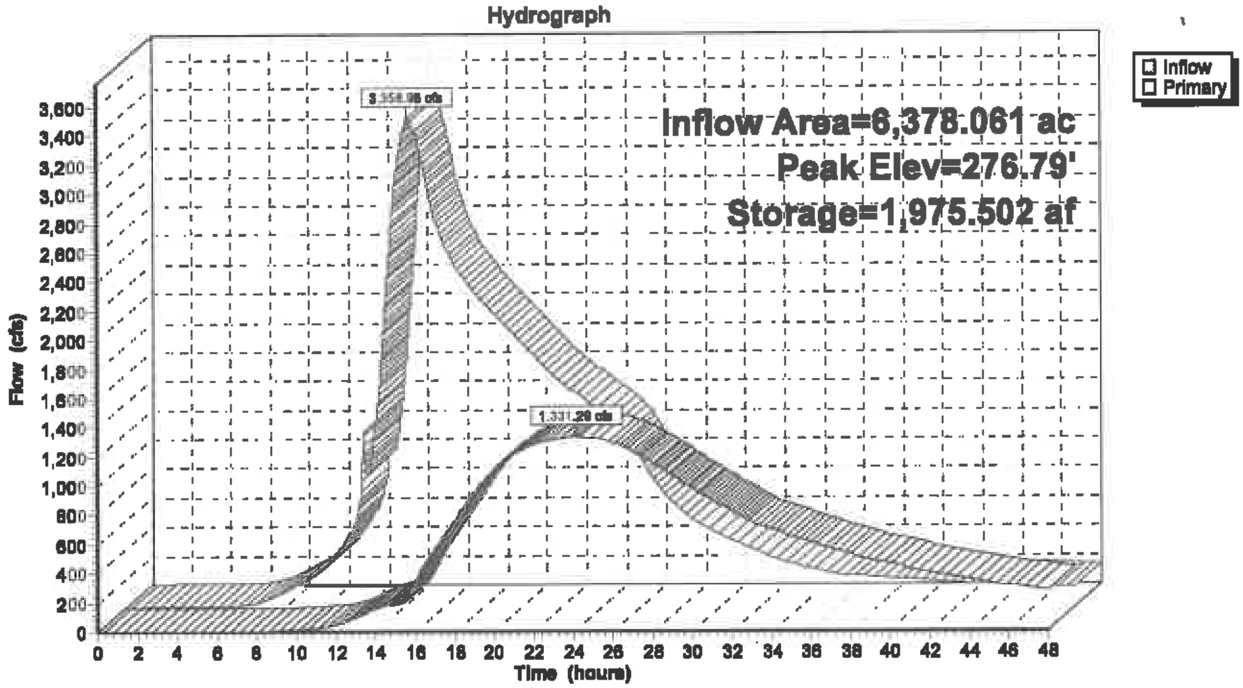


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" W x 9.0" H Vert. oriface 1** C= 0.600 |
| #3 | Primary | 272.80' | **86.0" W x 9.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 9.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 9.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 9.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=1,285.46 cfs @ 24.18 hrs HW=276.79' (Free Discharge)
├─**1=road** (Weir Controls 1,028.56 cfs @ 3.00 fps)
├─**2=oriface 1** (Orifice Controls 67.51 cfs @ 9.15 fps)
│ └─**7=Culvert 1** (Passes 67.51 cfs of 339.16 cfs potential flow)
├─**3=oriface 2** (Orifice Controls 49.21 cfs @ 9.15 fps)
│ └─**8=Culvert 2** (Passes 49.21 cfs of 247.18 cfs potential flow)
├─**4=oriface 3** (Orifice Controls 57.22 cfs @ 9.15 fps)
│ └─**9=Culvert 3** (Passes 57.22 cfs of 287.42 cfs potential flow)
├─**5=oriface 4** (Orifice Controls 56.64 cfs @ 9.15 fps)
│ └─**10=Culvert 4** (Passes 56.64 cfs of 284.55 cfs potential flow)
└─**6=oriface 5** (Orifice Controls 26.32 cfs @ 9.15 fps)
  └─**11=Culvert 5** (Passes 26.32 cfs of 132.21 cfs potential flow)

## Pond 16P: EXISTING_Hopedale Pond_wStoplogs_PostSW



# ALTERNATIVE 1

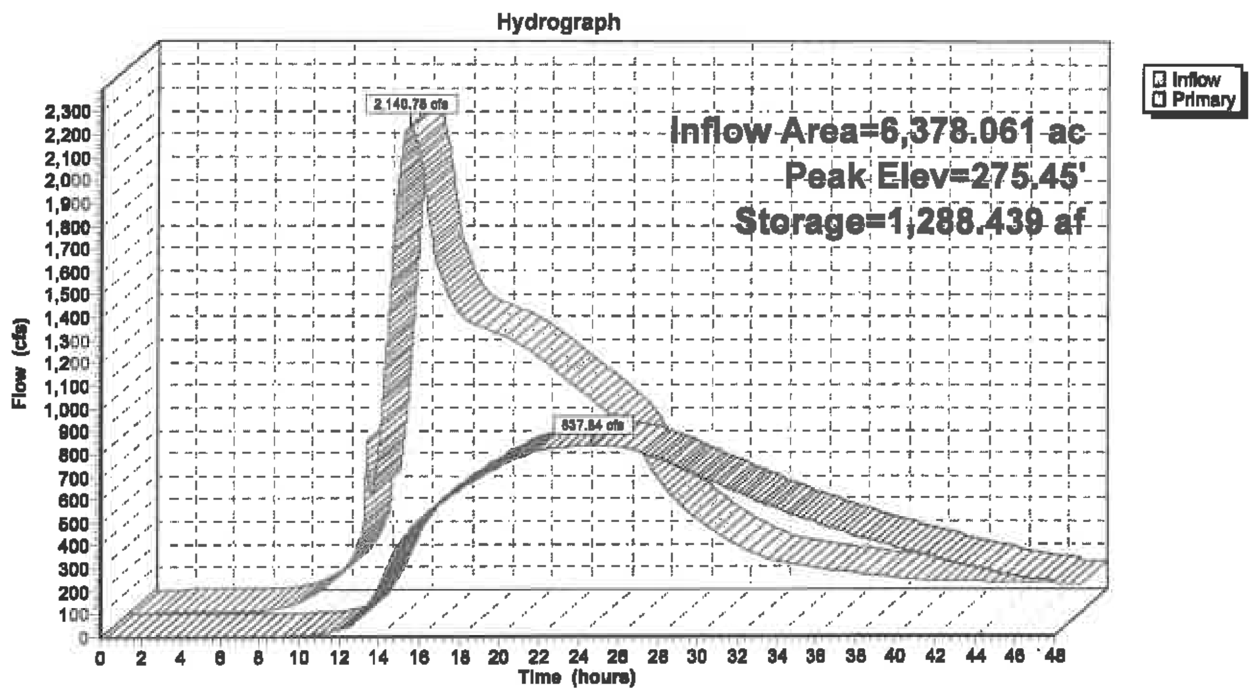


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 269.80' | **448.9" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 155.24 sf |
| #3 | Device 2 | 272.80' | **720.0" x 96.0" Horiz. Orifice** C= 0.600<br>Limited to weir flow at low heads |
| #4 | Device 3 | 272.80' | **60.0' long stoplogs** 2 End Contraction(s) |

**Primary OutFlow** Max=837.73 cfs @ 24.75 hrs HW=275.45' (Free Discharge)
↑—**1=road** ( Controls 0.00 cfs)
└—**2=Culvert 1** (Passes 837.73 cfs of 1,155.49 cfs potential flow)
  ↑—**3=Orifice** (Passes 837.73 cfs of 1,915.76 cfs potential flow)
    └—**4=stoplogs** (Weir Controls 837.73 cfs @ 5.32 fps)

## Pond 18P: TB_ALT_wStoplogs_PostSW

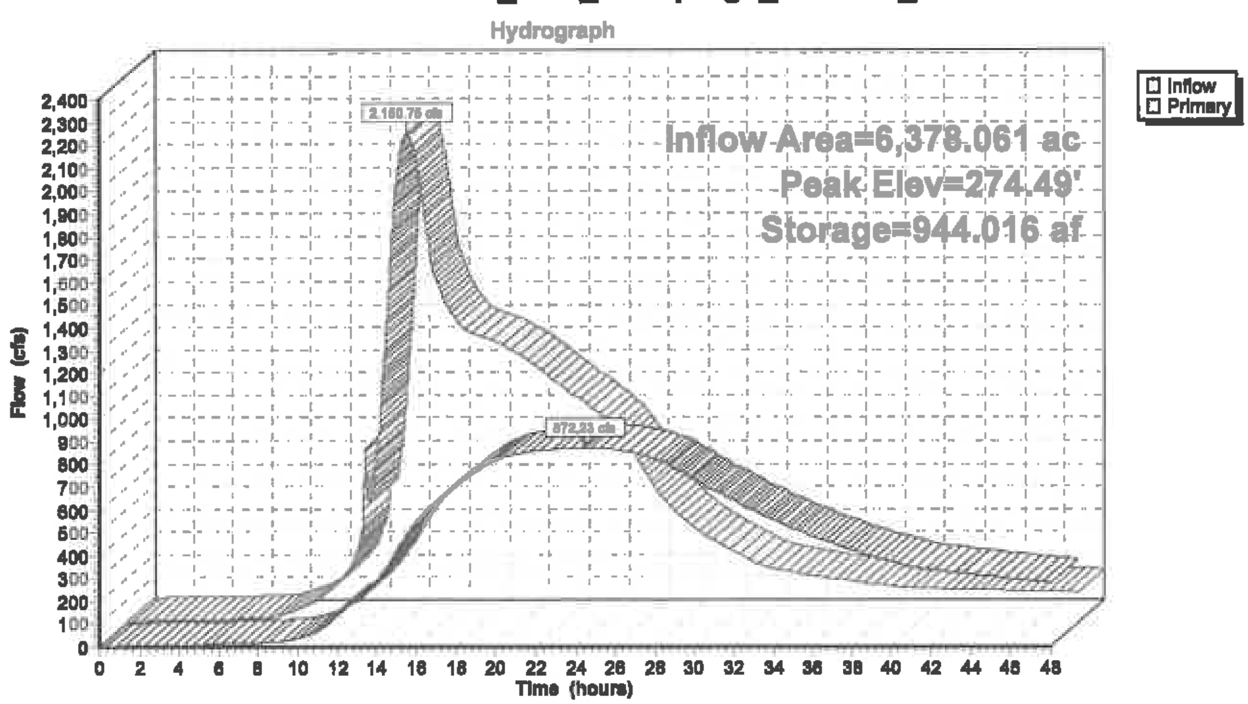


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 269.80' | **448.9" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 155.24 sf |
| #3 | Device 2 | 272.80' | **540.0" x 96.0" Horiz. Orifice** C= 0.600<br>Limited to weir flow at low heads |
| #4 | Device 2 | 268.90' | **180.0" x 96.0" Horiz. 15 ft Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |
| #5 | Device 4 | 268.90' | **15.0' long 15 ft weir** 2 End Contraction(s) |
| #6 | Device 3 | 272.80' | **45.0' long stoplogs** 2 End Contraction(s) |

**Primary OutFlow** Max=870.41 cfs @ 24.43 hrs HW=274.49' (Free Discharge)
—**1=road** ( Controls 0.00 cfs)
—**2=Culvert 1** (Barrel Controls 870.41 cfs @ 6.62 fps)
—**3=Orifice** (Passes < 759.34 cfs potential flow)
—**6=stoplogs** (Passes < 319.94 cfs potential flow)
—**4=15 ft Orifice/Grate** (Passes < 1,250.87 cfs potential flow)
—**5=15 ft weir** (Passes < 584.23 cfs potential flow)

**Pond 19P: TB_ALT_wStoplogs_PostSW_1HR**



# ALTERNATIVE 2

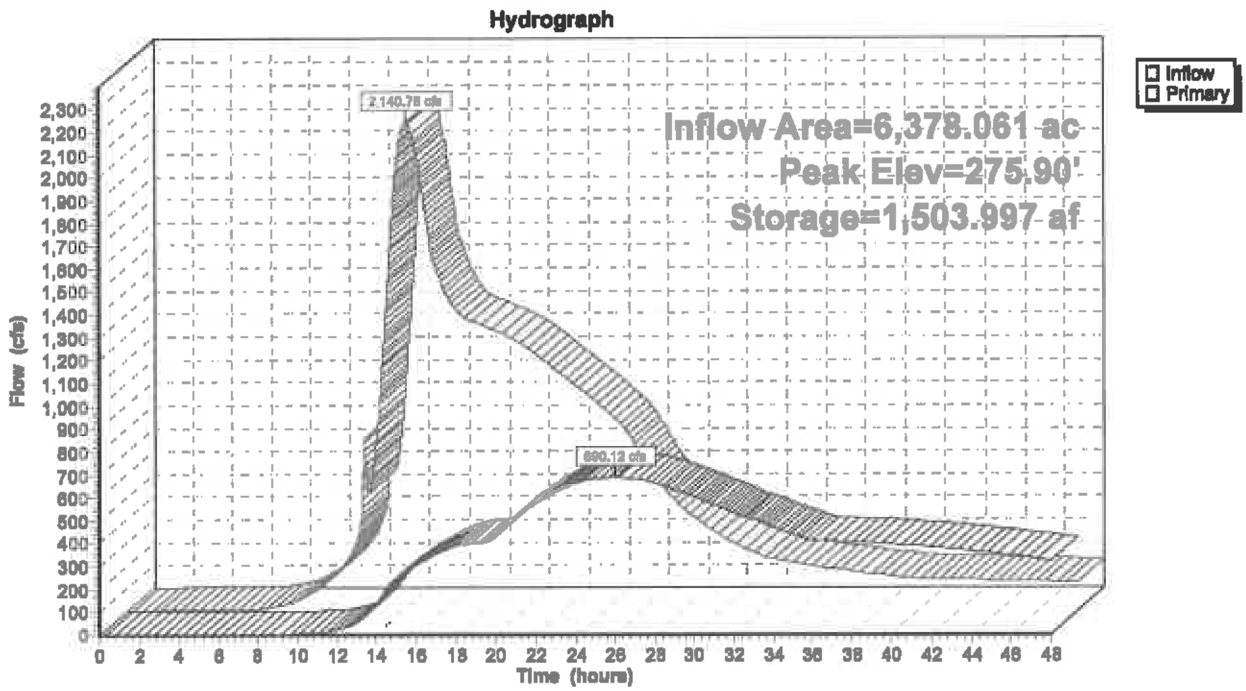


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #3 | Primary | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #4 | Primary | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #5 | Primary | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #6 | Primary | 269.80' | **46.0" W x 48.9" H Box Culvert 5**<br>L= 26.5' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.62 sf |
| #7 | Device 2 | 272.80' | **118.0" W x 17.4" H Vert. Orifice 1** C= 0.600 |
| #8 | Device 3 | 272.80' | **86.0" x 17.4" Horiz. Orifice 2** C= 0.600<br>Limited to weir flow at low heads |
| #9 | Device 4 | 272.80' | **100.0" x 17.4" Horiz. Orifice 3** C= 0.600<br>Limited to weir flow at low heads |
| #10 | Device 5 | 272.80' | **99.0" x 17.4" Horiz. Orifice 4** C= 0.600<br>Limited to weir flow at low heads |
| #11 | Device 6 | 272.80' | **46.0" x 17.4" Horiz. Orifice 5** C= 0.600<br>Limited to weir flow at low heads |
| #12 | Device 7 | 272.80' | **9.8' long stoplog 1** 2 End Contraction(s) |
| #13 | Device 8 | 272.80' | **7.2' long stoplog 2** 2 End Contraction(s) |
| #14 | Device 9 | 272.80' | **8.3' long stoplog 3** 2 End Contraction(s) |
| #15 | Device 10 | 272.80' | **8.2' long stoplog 4** 2 End Contraction(s) |
| #16 | Device 11 | 272.80' | **3.8' long stoplog 5** 2 End Contraction(s) |

**Primary OutFlow** Max=622.11 cfs @ 25.95 hrs HW=275.90' (Free Discharge)
- **1=road** (Weir Controls 178.00 cfs @ 1.70 fps)
- **2=Culvert 1** (Passes 105.28 cfs of 343.57 cfs potential flow)
  - **7=Orifice 1** (Orifice Controls 105.28 cfs @ 7.38 fps)
    - **12=stoplog 1** (Passes 105.28 cfs of 163.51 cfs potential flow)
- **3=Culvert 2** (Passes 88.03 cfs of 250.40 cfs potential flow)
  - **8=Orifice 2** (Orifice Controls 88.03 cfs @ 8.47 fps)
    - **13=stoplog 2** (Passes 88.03 cfs of 117.21 cfs potential flow)
- **4=Culvert 3** (Passes 102.37 cfs of 291.16 cfs potential flow)
  - **9=Orifice 3** (Orifice Controls 102.37 cfs @ 8.47 fps)
    - **14=stoplog 3** (Passes 102.37 cfs of 136.80 cfs potential flow)
- **5=Culvert 4** (Passes 101.34 cfs of 288.25 cfs potential flow)
  - **10=Orifice 4** (Orifice Controls 101.34 cfs @ 8.47 fps)
    - **15=stoplog 4** (Passes 101.34 cfs of 135.02 cfs potential flow)
- **6=Culvert 5** (Passes 47.09 cfs of 132.21 cfs potential flow)
  - **11=Orifice 5** (Orifice Controls 47.09 cfs @ 8.47 fps)
    - **16=stoplog 5** (Passes 47.09 cfs of 56.65 cfs potential flow)

## Pond 17P: BETA_ALT_wStoplogs_PostSW

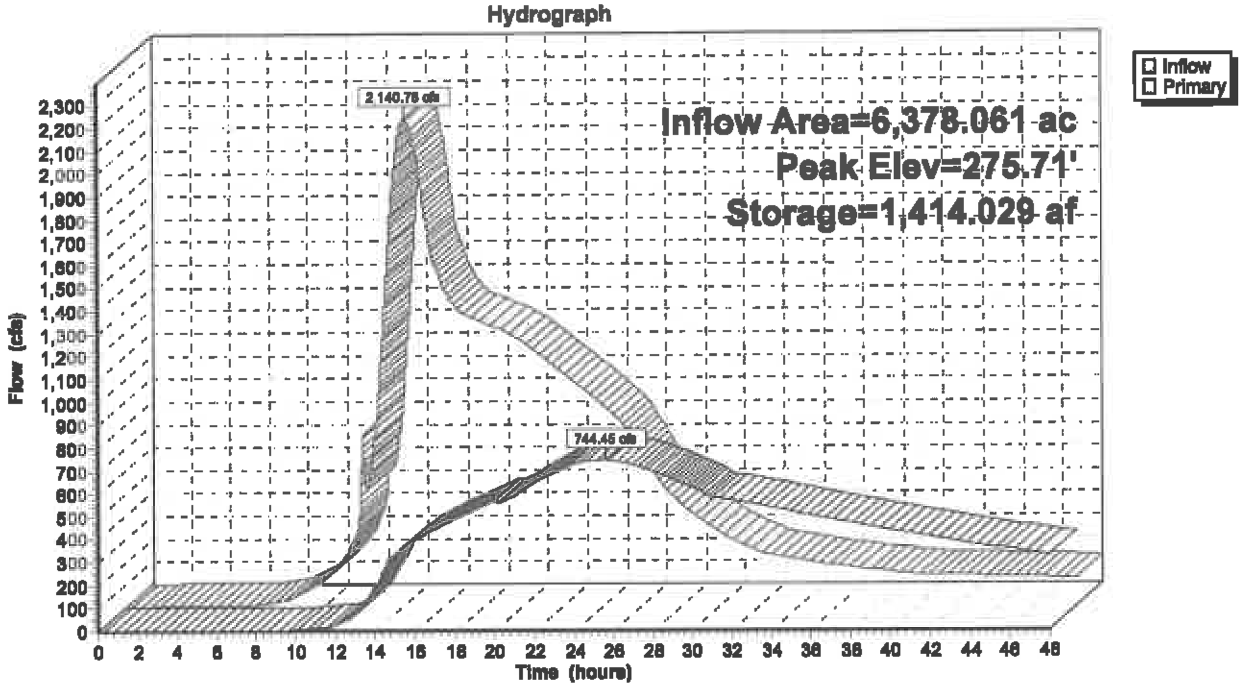


| | |
|---|---|
| 362.69 | 332,940.680 |
| 368.18 | 360,850.120 |
| 376.19 | 391,721.350 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 275.50' | **265.0' long x 28.0' breadth road**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60<br>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63 |
| #2 | Primary | 272.80' | **118.0" x 30.0" Horiz. oriface 1** C= 0.600<br>Limited to weir flow at low heads |
| #3 | Primary | 272.80' | **86.0" W x 30.0" H Vert. oriface 2** C= 0.600 |
| #4 | Primary | 272.80' | **100.0" W x 30.0" H Vert. oriface 3** C= 0.600 |
| #5 | Primary | 272.80' | **99.0" W x 30.0" H Vert. oriface 4** C= 0.600 |
| #6 | Primary | 272.80' | **46.0" W x 30.0" H Vert. oriface 5** C= 0.600 |
| #7 | Device 2 | 269.80' | **118.0" W x 49.8" H Box Culvert 1**<br>L= 30.0' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 40.81 sf |
| #8 | Device 3 | 269.80' | **86.0" W x 49.8" H Box Culvert 2**<br>L= 30.0' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 29.74 sf |
| #9 | Device 4 | 269.80' | **100.0" W x 49.8" H Box Culvert 3**<br>L= 30.0' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.58 sf |
| #10 | Device 5 | 269.80' | **99.0" W x 49.8" H Box Culvert 4**<br>L= 30.0' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 34.24 sf |
| #11 | Device 6 | 269.80' | **46.0" W x 49.8" H Box Culvert 5**<br>L= 30.0' Box, 0° wingwalls, square crown edge, Ke= 0.700<br>Inlet / Outlet Invert= 269.80' / 269.80' S= 0.0000 '/' Cc= 0.900<br>n= 0.011, Flow Area= 15.91 sf |

**Primary OutFlow** Max=685.63 cfs @ 25.57 hrs HW=275.71' (Free Discharge)
- **1=road** (Weir Controls 67.67 cfs @ 1.22 fps)
- **2=oriface 1** (Orifice Controls 201.87 cfs @ 8.21 fps)
  - **7=Culvert 1** (Passes 201.87 cfs of 286.95 cfs potential flow)
- **3=oriface 2** (Orifice Controls 108.11 cfs @ 6.03 fps)
  - **8=Culvert 2** (Passes 108.11 cfs of 209.13 cfs potential flow)
- **4=oriface 3** (Orifice Controls 125.71 cfs @ 6.03 fps)
  - **9=Culvert 3** (Passes 125.71 cfs of 243.18 cfs potential flow)
- **5=oriface 4** (Orifice Controls 124.45 cfs @ 6.03 fps)
  - **10=Culvert 4** (Passes 124.45 cfs of 240.75 cfs potential flow)
- **6=oriface 5** (Orifice Controls 57.82 cfs @ 6.03 fps)
  - **11=Culvert 5** (Passes 57.82 cfs of 111.86 cfs potential flow)

## Pond 20P: TB_ALT2_Hopedale Pond_wStoplogsDS_PostSW



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